Operating and Service Manual

MAHLER

GOULD 110

STRIP CHART RECORDER

15-4318-00, 15-4328-00*

MP MASTER

MA27800

GOULD

GOULD BRUSH

MANUAL PART NO.
110-804300-2

GOULD 110

STRIP CHART RECORDER

15-4318-00, 15-4328-00*

* See Section 1.5 for additional model Nos.

with

High Gain Multi-Span DC Preamplifier	13-4715-06
Fixed-Span DC Preamplifier	13-4715-07
Input Signal Coupler	13-4715-08
Medium Gain Multi-Span DC Preamplifier	13-4715-09

NOTE: For information on the Thermocouple Preamplifier 13-4715-4X see separate manual.

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SECTION I

GENERAL INFORMATION

1.1 SCOPE

This manual describes the Gould 110 strip chart recorder (Figure 1-1) and provides instructions for installation, operation, troubleshooting, and maintenance procedures. Theory of operation, and calibration procedures are also furnished. An illustrated parts breakdown is located in the rear of the manual.

1.2 DESCRIPTION

The Gould 110 is a ten inch multi-speed strip chart recorder that is available in single or dual channel models. A series of plug-in signal conditioning modules and accessories are available to tailor the recorder to a specific application.

The model 110 utilizes a thermal writing technique with ceramic tip pens and dual heat controls that produce permanent blue traces on special paper which does not smudge from pressure or handling.

This thermal writing technique is superior to the conventional capillary ink writing method. Pen clogging and pen tip dry-out is eliminated. This writing technique also provides electrically adjustable trace density, superior writing system reliability, and permits operation in any position.

The recorder utilizes sprocket driven NCR thermal chart paper with a 9.75 inch wide grid. A full 120-foot roll of paper is easily loaded in the removable writing table assembly. For maximum convenience of viewing, the table may be positioned at any of three angles.

Ten chart speeds from one inch/hour to eight inches/minute are switch selectable, and the chart drive can be started and stopped from either front panel or remote controls. The external pulse input is TTL compatible and permits the chart to be pulse driven and synchronized for operation with external devices. An external pulse input from 0 to 120 pulses/sec. will provide chart speeds from 0 to 8 inches/minute.

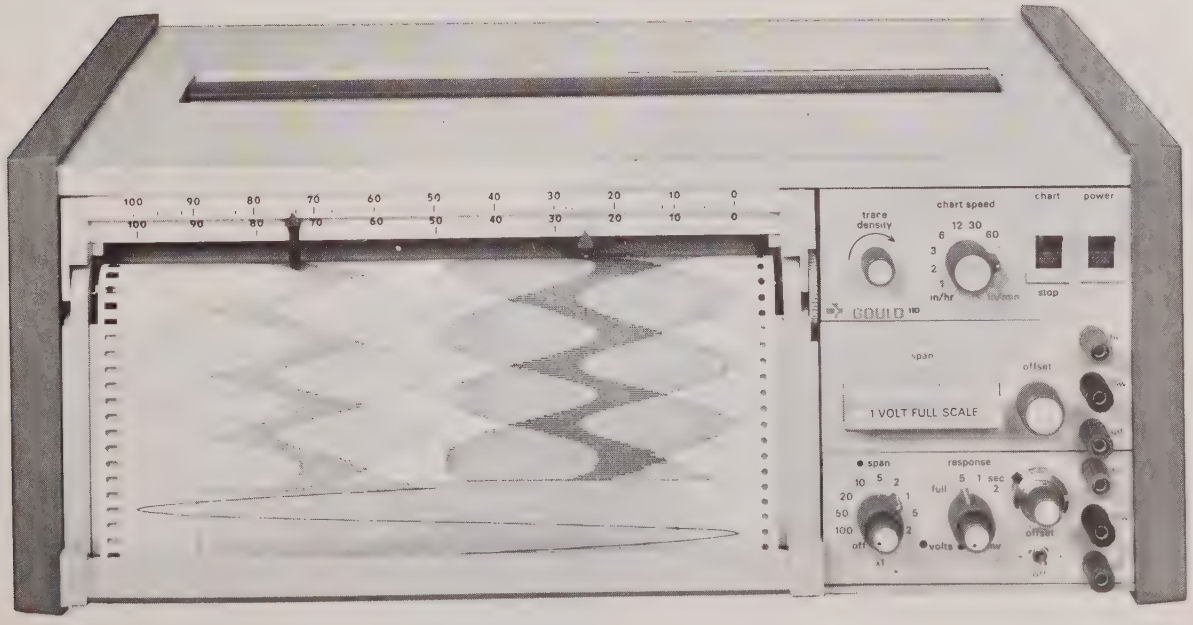

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FIGURE 1-1 GOULD 110 STRIP CHART RECORDER

Fixed and multi-span preamplifiers are available with the strip chart recorder. Plug-in signal conditioners are available with a selection of different input voltages. Signal conditioners plug into the front panel and are powered by the drive amplifier power supply located in the recorder. High accuracy at low signal levels is achieved by the use of a chopper stabilized amplifier which corrects for errors caused by the input offset voltage and current drifts. The following preamplifiers may be ordered with the recorder.

- Input Signal Coupler 13-4715-08 (Figure 1-2)- Provides pen positioning, internal calibration, and seven full-scale ranges of 1, 2, 5, 10, 20, 50, and 100 volts from low impedance sources.

- Fixed Span DC Preamplifier 13-4715-07(Figure 1-3) - Precision signal conditioner, utilizing a chopper amplifier with pen positioning and a choice of 16 plug-in fixed gain printed circuit cards which provide full-scale ranges from 1 millivolt to 100 volts.

- Medium Gain Multi-Span DC Preamplifier 13-4715-09 (Figure 1-4) - A signal conditioner with 16 switch selectable, full-scale ranges from 1 millivolt to 100 volts, in addition to zero offset control and switch selectable output filtering (response).

- High Gain Multi-Span DC Preamplifier 13-4715-06 (Figure 1-5) - Chopper amplifier signal conditioner with 18 switch selectable, full-scale ranges from 100 microvolts to 100 volts, in addition to calibrated zero offset and switch selectable output filtering.

- Thermocouple Preamplifier 13-4715-4X (See separate manual) ..... - Cold junction compensation and electronic thermocouple linearization provide direct temperature read-out in degrees, selectable to F or C. Front panel controls also include a seven position range switch, vernier, and calibrated zero suppression controls.

An optional electronic chart integrator (11-6105-00, 01) is available. At any given time, the integrator pen indicates and records the total accumulated area under its corresponding analog pen trace of input signal verses time. Thus the integrator output is independent of chart speed. This display occupies a one inch wide chart strip located to the right of the analog channel display.

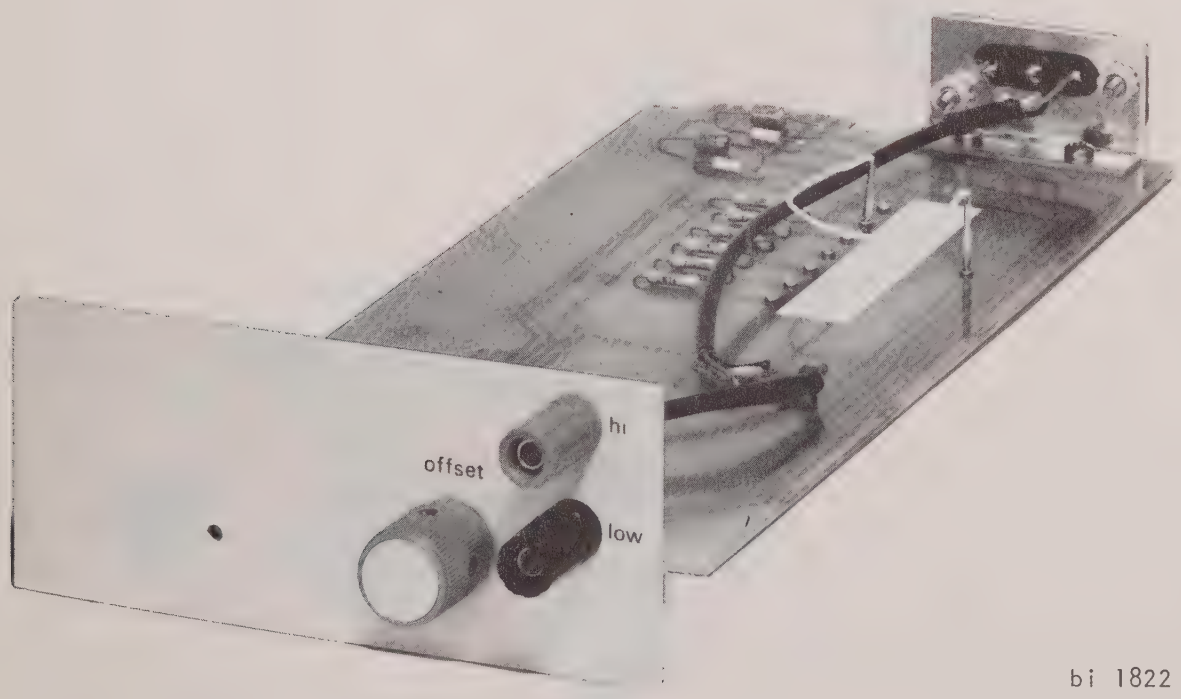


FIGURE 1-2 INPUT SIGNAL COUPLER (13-4715-08)

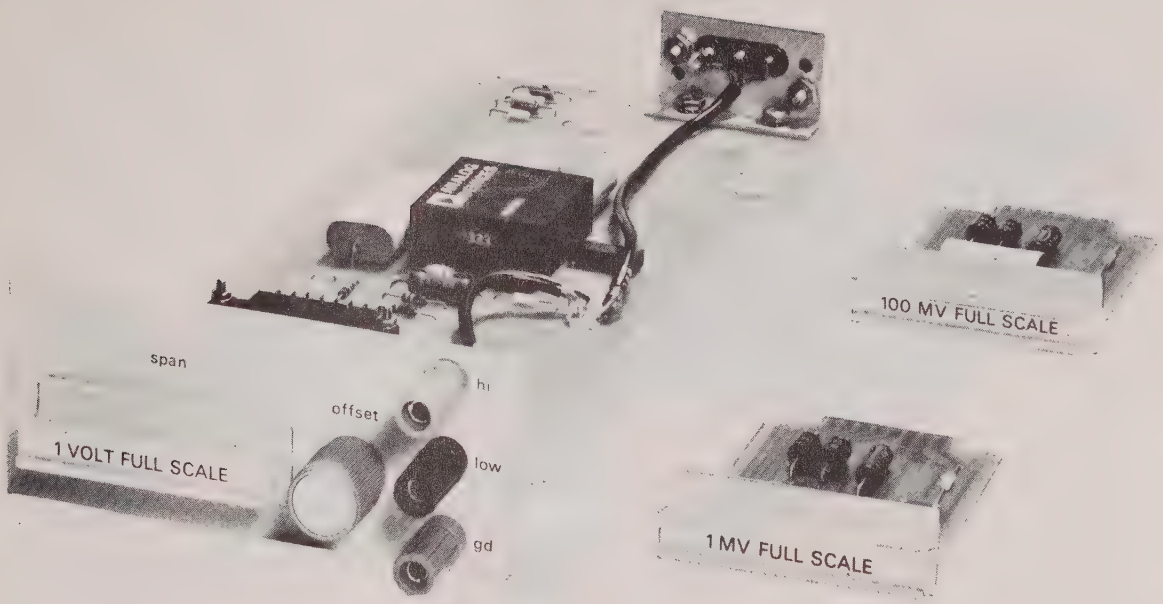


FIGURE 1-3 FIXED SPAN DC PREAMPLIFIER (13-4715-07)

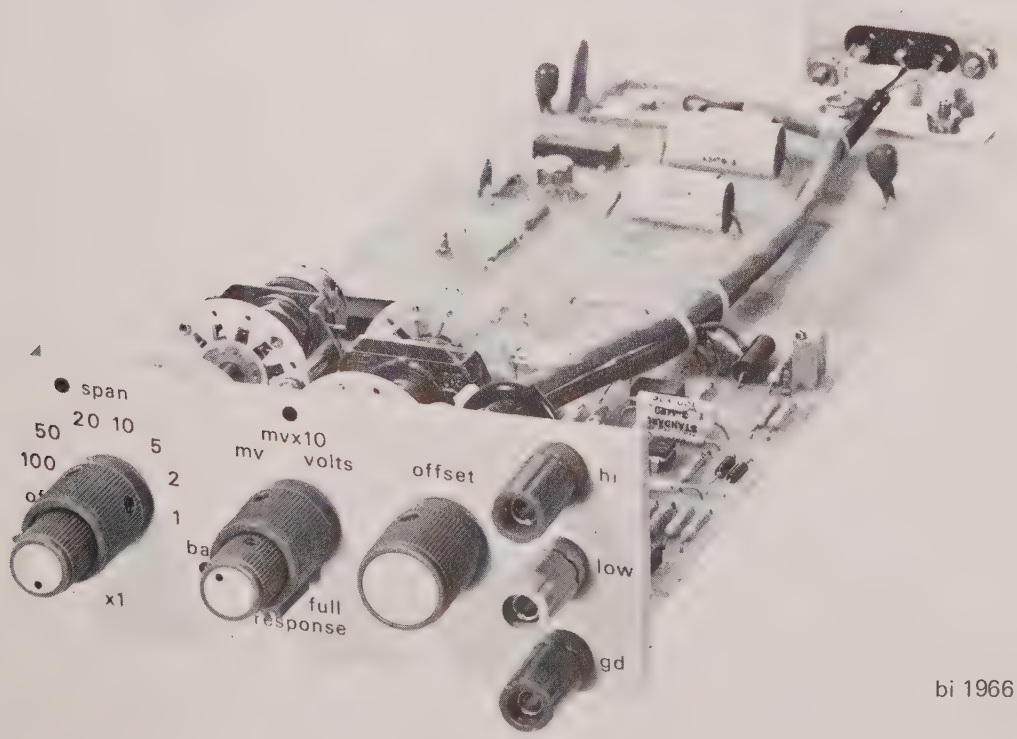


FIGURE 1-4 MEDIUM GAIN MULTI-SPAN DC PREAMPLIFIER (13-4715-09)

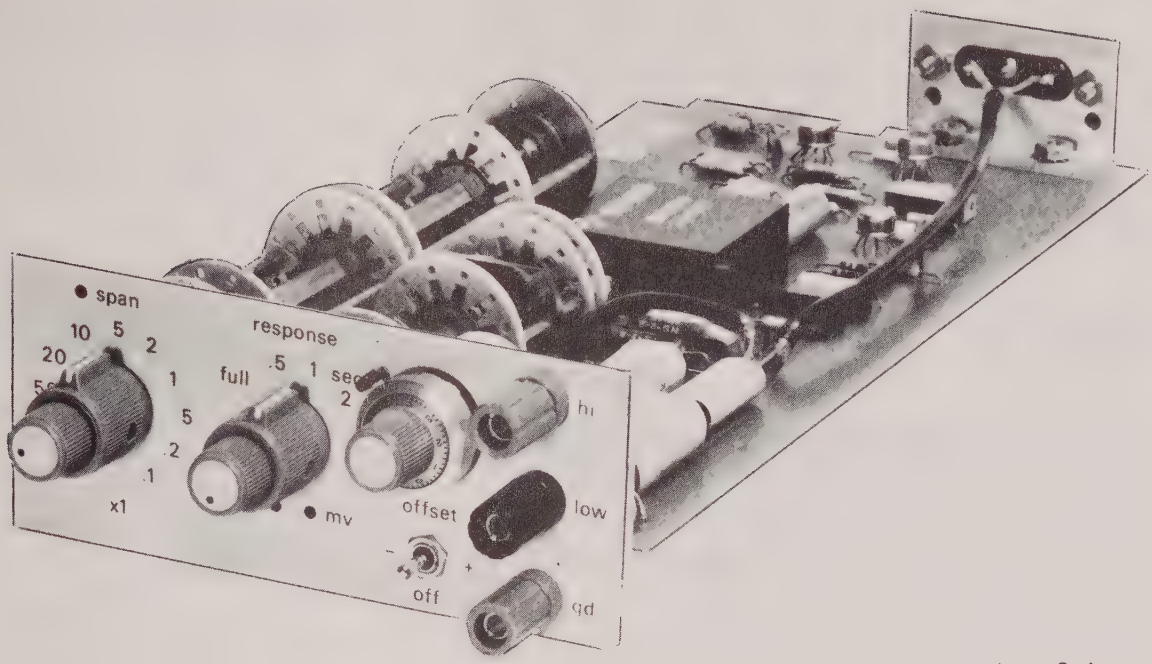


FIGURE 1-5 HIGH GAIN MULTI SPAN DC PREAMPLIFIER (13-4715-06)

1.3 RECORDER SPECIFICATIONS

1.3.1 General

	Portable	Rack Mounted
Overall Size	Height: 7.8 in. (19.8 cm) Width: 19 in. (48.3 cm) Depth: 14.1 in. (35.8 cm)	7 in. (17.8 cm) 19 in. (48.3 cm) 14.1 in. (35.8 cm)

Weight
- Single Channel ..... 28 lbs. (12.5 kg.)
- Dual Channel ..... 33 lbs. (15.0 kg.)

Channels
- Analog ..... One standard (second full width channel optional)
- Integrator ..... One optional (sharing same time line with analog channel number one)

Event Marker ..... Located on left and right margins (optional)

Writing Method ..... Hot tip thermal pen

Trace Presentation ..... Rectilinear

Trace Width ..... Adjustable pen heat with front panel control

Signal Limiters ..... Built-in adjustable electronic

Writing Table ..... Vertical (may be tilted to writing positions of 15° and 30° off vertical or removed)

1.3.2 Chart Transport

Speed
- English ..... 1,2,3,6,12,30, and 60 in/hr. (2,4, and 8 in/min.)
- Metric ..... 2.5, 5, 7.5, 15, 30, 75 and 150 cm/hr. (5, 10, and 20 cm/min.)

Chart Speed Accuracy ..... Sprocket drive, speed error non-cumulative at nominal line frequency.

Paper Wander ..... Less than ±0.1 division

Paper Interlock ..... Automatic sensing of chart paper; shuts down heat, servo, and chart drive when paper supply is exhausted.

Chart Paper
- Length ..... 120 ft. (roll with length of paper remaining printed on chart edge.)
- Width ..... 11 in.
- Roll Diameter ..... 2.5 in. (max.)

Paper Discharge ..... From bottom of transport or may be internally rewound.

Chart Paper Grid

All Models ..... Precision printed and registered grids. Event marker channels on left and right margins.

English (standard) ..... 9.75 in. analog channel width divided into 100 longitudinal (amplitude) lines with every fifth accentuated. 0.1 in. traverse (timing) lines with every fifth accentuated.

English (with integrator channel) ..... 7.7 in. analog channel width divided into 100 longitudinal divisions with every fifth accentuated, plus three additional longitudinal divisions on the right providing a total channel width of 103 divisions. 0.1 in. transverse lines with every fifth accentuated on both analog and integrator channels. 0.975 inch integrator channel divided into ten longitudinal divisions.

Metric ..... Same as "English Standard" except 2.0 mm transverse lines with every fifth accentuated.

Metric (with integrator channel) ..... Same as "English Standard with integrator channel" except 2.0 mm transverse lines on both analog and integrator channels with every fifth accentuated.

1.3.3 Electrical

Power Input ..... 115 vac, 60 Hz, 44 va (single channel)
115 vac, 60Hz, 69 va (dual channel)

Remote Start and Stop ..... Actuated by an external switch closure at preselected chart speed.

External Pulse Drive ..... TTL compatible input signal to a maximum of +30 volts.

Paper Travel

60Hz Unit ..... 900 pulses/in; 360 pulses/cm (Metric)
50Hz Unit ..... 750 pulses/in.; 300 pulses/cm (Metric)

Input Pulse Repetition Rate ..... 240 pulses/second (maximum) from external source.

Current Consumed by Options

Limit Switches ..... 21 ma (single channel) 41 ma (dual channel)
Chart Integrator ..... 17 ma
Fixed Gain Preamplifier ..... 1.7 ma
Multi Span Preamplifier ..... 1 ma
Event Marker ..... 200 ma (each)

Response Time ..... 0.25 sec. full scale (maximum)

Inaccuracy ..... ±0.15% of full scale (including non-linearity and deadband) at 25°c.

Non-Linearity ..... ±0.1% of full scale.

1.3.4 Environmental

Operating Temperature Range ..... 0° to +50° C (+32° F to +122° F)

Storage
- Without Chart Paper ..... -40° C to +85° C (-40° F to +185° F)
- With Chart Paper ..... -40° C to +70° C (-40° F to +158° F)

Vibration and Shock ..... Standard commercial practice

1.3.5 Integrator Specifications (Model 11-6105-00 and -01)

Integration Accuracy ..... ±0.25% of full scale count rate per minute under normal operating conditions.

Integrator Setability ..... ±2 counts per minute under normal operating conditions.

Full-Scale Count Rate ..... 6000 counts per minute.

Overrange Capability ..... 400% of full scale count rate to 24,000 counts per minute (maximum)

Integrator Channel Width ..... 0.975 inch to right of analog channel divided into ten divisions.

Threshold of Integration ..... Less than 10 millivolts. Referred to analog channel input.

Stability .....

	ZERO	GAIN
TIME	1 Count/Min. / 24 Hrs.	.01% / 24 Hrs.
TEMP.	1.5 Counts/Min. / C°	.075%/C°
LINE	0.05 Counts/Min. / %△	0.01 / %△

Polarity Indication ..... Blips occur on upscale peaks for positive integration and on the down scale peaks for negative integration. 600 or 1000 count blip interval selectable by switch on P.C. Board Assy.

Environmental ..... a) Operating 0-50° C.
b) Storage -40° C to 85° C.
c) Humidity: 80% @ 32° C. (W/O Condensation).

1.4 PREAMPLIFIER SPECIFICATIONS

1.4.1 Input Coupler 13-4715-08

Measurement Range ..... 1 volt full scale to 100 volts full scale, dependent on internal connection.

Sensitivity ..... 1,2,5,10,20,50, and 100 volts full scale (internally selectable)

Accuracy ..... ±.25% of full scale, settable using front panel trim control.

Input Circuit ..... Floating & Guarded.

Zero Offset ..... ±100% of Full scale.

Input Resistance ..... 10K ohms minimum (attenuator into 10K ohms of drive amplifier) 10K ohms/volt.

Maximum Allowable Input Voltage ..... 100 volts dc or peak ac as normal mode

Common Mode Rejection ..... Greater than 120 db at dc with 1000-ohm unbalance. Greater than 80dB at 60Hz with 1000-ohm unbalance.

Maximum off-Ground Voltage ..... 220 volts dc or peak ac.

Zero Line Instability (After 30-minute warm-up) ..... ±0.1% of full scale for 24 hours. ±0.1% of full scale per °C ±0.05% of full scale per 10% line change.

Gain Instability (After 30-minute warm-up) ..... ±0.01% of reading for 24 hours ±0.01% of reading per °C (on 100 volts full scale) ±0.01% of reading for 10% line change

Output Noise ..... ±0.1% of full scale

Operating Temperature ..... 0° C to 50° C (+32° F to +122° F)

Storage Temperature ..... -40° C to +85° C (-40° F to +185° F)

Vibration and Shock ..... Standard commercial practice

Operating Input Voltage ..... See "Recorder Specification"

Signal Input Connection ..... Front panel: 2 binding posts (Hi and Lo); Rear panel: Barrier strip (screw type)

Weight (Coupler only) ..... 1 pound (0.45 Kilogram)

Dimensions (Coupler only) ..... 2.125 in. H x 5 in. W x 12.75 in. D (5.4 cm H x 12.7 cm W x 32.4 cm D)

Trim Control ..... Adjusts any full scale sensitivity except the 1 volt range, which is factory set in the pen drive amplifier.

1.4.2 Fixed Span DC Preamplifier 13-4715-07

Measurement Range ..... 1 millivolt full scale to 100 volts full scale, dependent on Range Card selected.

Sensitivity with plug-in Model	11-4601-01 Range Card	1 millivolt full scale
	11-4601-02 Range Card	2 millivolts full scale
	11-4601-03 Range Card	5 millivolts full scale
	11-4601-04 Range Card	10 millivolts full scale
	11-4601-05 Range Card	20 millivolts full scale
	11-4601-06 Range Card	50 millivolts full scale
	11-4601-07 Range Card	100 millivolts full scale
	11-4601-08 Range Card	200 millivolts full scale
	11-4601-09 Range Card	500 millivolts full scale
	11-4601-10 Range Card	1 volt full scale
	11-4601-11 Range Card	2 volt full scale
	11-4601-12 Range Card	5 volts full scale
	11-4601-13 Range Card	10 volts full scale
	11-4601-14 Range Card	20 volts full scale
	11-4601-15 Range Card	50 volts full scale
	11-4601-16 Range Card	100 volts full scale

Inaccuracy ..... ±0.25% of full scale or 2 microvolts (whichever is greater) at 25° C

Input Circuit ..... Floating and guarded

Input Impedance ..... Potentiometric (>80 kilohms) from 1 millivolt to 100 millivolts full scale; 1 megohm from 200 millivolts to 100 volts full scale.

Common Mode Rejection ..... 120 dB at dc and 60Hz with 1-kilohm unbalance

Maximum Allowable Input Voltage ..... 220 volts dc or peak ac normal mode or common mode

Zero Line Instability (After 30-minute warm-up ..... ±0.1% of full scale for 24 hours
±0.1% of full scale per °C
±0.05% of full scale per 10% line change

Gain Instability (After 30-minute warm-up) ..... ±0.01% of reading for 24 hours
±0.01% of reading per °C
±0.01% of reading for 10% line change

Output Noise ..... ±0.1% of full scale

Zero Offset ..... ±100% of full scale

Operating Temperature ..... 0° C to 50° C (+32° F to +122° F)

Storage Temperature ..... -40° C to +85° C (-40° F to +185° F)

Vibration and Shock ..... Standard commerical practice

Operating Input Voltage ..... See "Recorder Specification"

Power Input 0.2VA

Weight (preamplifier only) ..... 1 pound (0.45 kilogram)

Dimensions (preamplifier only) ..... 2.125 in. H x 5 in. W x 12.75 D (5.4 cm H x 12.7 cm W x 32.4 cm D)

Signal Input Connection ..... Front panel: 3 binding post; Rear panel; Barrier Strip

1.4.3 High Gain Multi-Span D.C. Preamplifier 13-4715-06

Measurement Range ..... 40 microvolts full scale to 100 volts full scale

Attenuator Steps ..... 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50 and 100 millivolts full scale; 0.1, 0.2, 0.5, 1.2, 5, 10, 20, 50 and 100 volts full scale and OFF

Inaccuracy ..... ±0.25% of full scale or 2 microvolts (whichever is greater) at 24° C ±2° C

Sensitivity Vernier ..... Continuously increases full scale sensitivity up to 3 times.

Input Circuit ..... Floating and guarded

Input Impedance ..... Potentiometric (>80 kilohms) in millivolt mode: 1 megohm in volt mode

Common Mode Rejection ..... Greater than 120 dB at dc and 60Hz with 1 kilohm unbalance

Maximum Allowable Input Voltage ..... 220 volts dc or peak ac normal mode or common mode

Zero Line Instability (After 30-minute warm-up) ..... ±0.1% of full scale for 24 hours
±0.1% of full scale per °C
±0.05% of full scale for 10% line change

Gain Instability (After 30-minute warm-up) ..... ±0.01% of reading for 24 hours
±0.01% of reading per °C
±0.01% of reading for 10% line change

Response Time of Selectable Output Filter

Full Position ..... 0.25 second full scale maximum
0.5 Position ..... 0.5 second full scale ±20%
1.0 Position ..... 1.0 second full scale ±20%
2.0 Position ..... 2.0 seconds full scale ±20%

Calibrated Zero Offset

Range ..... ±10 times full scale
Resolution ..... ±0.1% of zero offset range
Non-Linearity ..... ±0.5% of zero offset range
Inaccuracy ..... ±0.5% of zero offset range

Stability (after 30-minute warm-up)

With Time ..... ±0.1% for 24 hours
With Temperature ..... ±0.01% per °C
With Line ..... ±0.1% for 10% line change

Operating Temperature ..... 0° C to +50° C (+32° F to +122° F)

Storage Temperature ..... -40° C to +85° C (-40° F to +185° F)

Vibration and Shock ..... Best commercial practice

Operating Input Voltage ..... See "Recorder Specification"

Power Input 0.1VA

Weight (preamplifier only) ..... 1¼ pounds (0.57 kilogram)

Dimensions (preamplifier only) ..... 2.125 in. H x 5 in. W x 12.75 in. D (5.4 cm H x 12.7 cm W x 32.4 cm D)

Signal Input Connection ..... Front panel: 3 binding posts; Rear panel: Barrier Strip

1.4.4 Medium Gain Multi Span D.C. Preamplifier 13-4715-09

Measurement Range ..... 400 microvolts full scale to 100 volts full scale

Attenuator Steps ..... 1, 2, 5, 10, 20, 50, 100, 200, 500 and 1000 millivolts full scale; 1, 2, 5, 10, 20, 50 and 100 volts full scale and OFF

Inaccuracy ..... ±0.1% range to range (±0.2% on 1mv and 2mv full scale ranges) at 24° C ±2° C

Sensitivity Vernier ..... Continuously increases full scale sensitivity up to 2.5 times.

Input Circuit ..... Single ended, floating and guarded

Input Impedance ..... 1 megohm constant.

Common Mode Rejection ..... Greater that 120 dB at dc and 50 to 400 Hz with 1 kilohm unbalance

Maximum Allowable Input Voltage ..... 220 volts dc or peak ac normal mode or common mode

Zero Line Instability (After 30-minute warm-up) ..... ±0.1% of full scale for 24 hours
±0.1% of full scale per °C

Gain Instability (After 30-minute warm-up) ..... ±0.01% of reading for 24 hours (or ±0.05%/10000 Hrs.)
±0.01% of reading per °C
±0.01% of reading for 10% line change

Response Time of Selectable Output Filter

Full Position ..... 0.070 second full scale maximum
0.5 Position ..... 0.5 second full scale ±20%

Operating Temperature ..... 0° C to +50° C (+32° F to +122° F)

Storage Temperature ..... -40° C to 75° C (-40° F to +167° F)

Vibration and Shock ..... Best commercial practice

Operating Input Voltage ..... See "Recorder Specification"

Power Input 0.1VA

Weight (preamplifier only) ..... 1 pound (0.4 kilogram)

Dimensions (preamplifier only) ..... 2.125 in. H x 5 in. W x 12.75 in D (5.4 cm H x 12.7 cm W x 32.4 cm D)

Signal Input Connection ..... Front panel: 3 binding posts; Rear panel: Barrier Strip

1.5 MODELS

Table 1-1 lists the various models that are available in the 110 series.

PORTABLE RECORDERS (less preamplifiers)	MODEL NUMBER
Single channel, English chart speeds, 115VAC, 60Hz	15-4318-00
Single channel, metric chart speeds, 115VAC, 60Hz	15-4318-10
Dual channel, English chart speeds, 115VAC, 60Hz	15-4328-00
Dual channel, metric chart speeds, 115VAC, 60Hz	15-4328-10
RACK MOUNTED RECORDERS (less preamplifiers)	MODEL NUMBER
Single channel, English chart speeds, 115VAC, 60Hz	15-4618-00
Single channel, metric chart speeds, 115VAC, 60Hz	15-4618-10
Dual channel, English chart pseeds, 115VAC, 60Hz	15-4628-00
Dual channel, metric chart speeds, 115VAC, 60Hz	15-4628-10

NOTE: For 230V, 50Hz operation, change last digit in model number suffix from 0 to 6. EX: 15-4318-00 is 115V, 60Hz. 15-4318-06 is 230V, 50Hz. For 115Volts, 50Hz operation, change last digit from 0 to 5.

TABLE 1-1 GOULD 110 STRIP CHART RECORDER MODELS

1.6 OPTIONS

Table 1-2 lists the options that are available with the Gould 110 strip chart recorder.

OPTIONS (Must be ordered with Recorder)	MODEL NUMBER
Chart Integrator for single channel recorder	11-6105-00
Chart Integrator for dual channel recorder	11-6105-01
Limit Switches for channel one only	11-6103-01
Limit Switches for channels one and two	11-6103-02
Retransmitting Potentiometer (10 Kohms) for channel one	11-6102-01
Retransmitting Potentiometer (10 Kohms) for channel two	11-6102-02

TABLE 1-2 GOULD 110 OPTIONS

1.7 ACCESSORIES

Table 1-3 is a list of accessories that may be purchased with the Gould 110.

ACCESSORIES	MODEL NUMBER
Left margin event marker	11-6222-16
Right margin event marker	11-6222-17
Dust Cover	486821
Signal Conditioner extender board & cable assembly	788956
Servo amplifier extender board	886604
Starter Kit (Includes 12 rolls of chart paper, gram gage and dust cover)	
English standard	11-6250-06
Metric standard	11-6250-07
English standard with integrator channel on chart	11-6250-08
Metric standard with integrator channel on chart	11-6250-09

TABLE 1-3 ACCESSORIES

1.8 SUPPLIES

Supplies may be ordered with the Gould 110 as listed in Table 1-4.

SUPPLIES	MODEL NUMBER
English chart paper	11-2915-10
Metric chart paper	11-2915-11
English chart paper with integrator channel	11-2915-12
Metric chart paper with integrator channel	11-2915-13
Upper channel stylus	11-2824-36
Lower channel stylus	11-2824-37
Left event marker stylus	11-2874-11
Right event marker stylus	11-2874-12
Integrator stylus	11-2874-33

TABLE 1-4 STRIP CHART RECORDER SUPPLIES

SECTION II

INSTALLATION

2.1 GENERAL

This section contains information necessary to put the recorder into service, including installation of optional equipment.

2.2 SERVICE UPON RECEIPT

Before making signal connections and applying power to the recorder, the following service must be performed:

a. Remove packing material from recorder.

b. Visually inspect unit for damage that may have occurred during shipment.

c. Operate front panel controls (they should turn freely with no binding).

d. Check for free removal and insertion of writing table. There should be no binding in the seats of the end blocks, or the catches in sideplates.

e. Check paper alignment by turning thumbwheel and manually advancing paper. Allow paper to feed out of the unit while observing that holes in paper align with sprocket teeth and paper tracks smoothly without obstruction to paper travel.

f. To check internal take-up, remove writing table and attach free end of paper to take-up core with tape. Manually advance paper by turning thumbwheel. Paper should wind onto take-up core reasonably tight without overriding sprockets.

g. Install rack-mounted models as shown in Figure 2-1.

2.3 PREAMPLIFIERS

2.3.1 Input Signal Coupler (13-4715-08)

a. Insert signal coupler into the recorder mainframe (component side up) being certain that the module is guided into the printed circuit card holder grooves of the recorder mainframe. Push the signal coupler all the way in, the board should mate with the rear card connector.

b. Rotate "OFFSET" knob. This control should turn freely without binding or scraping.

2.3.2 Fixed Span (13-4715-07) and Gain Module(s)

a. Insert gain module card (11-4601-xx) into front panel rectangular opening (component side up) of the fixed span preamplifier.

b. When gain module card is inserted into card edge connector, the handle base of the module should be flush with the front panel of the preamplifier.

c. Rotate "OFFSET" knob. This control should turn freely without binding.

d. Inspect the three front input terminals on the preamplifier. The terminals should be tight and not turn as the wire securing nut is tightened or loosened.

e. Insert the preamplifier into the recorder mainframe being certain that the hole in the preamplifier securing brackets line up with the holes in the recorder mainframe.

2.3.3 Multi-Span (13-4715-06 & 13-4715-09)

a. Rotate all knobs on the preamplifier front panel. There should be no binding or scraping.

b. Inspect the three front input terminals on the preamplifier front panel. The binding posts should be tight and not turn as the wire securing nut is tightened or loosened.

c. Insert the preamplifier into the recorder mainframe being certain that it is not binding and the front panel does not interfere with other panel surfaces.

d. When the preamplifier is inserted into the recorder, be certain that the holes in the preamplifier securing brackets line up with the holes in the recorder mainframe.

2.4 ELECTRICAL CONNECTIONS

2.4.1 Signal Connections

Input signal connections are made via binding post terminals located on the preamplifier front panel (two posts for a signal coupler, three posts for fixed or multi-span preamplifiers) or rear input

connection terminal strips (see Figure 3-2) located at the rear of the recorder. For high level signal source applications the LOW input terminal should be jumpered to the GD (guard) input terminal (see Figures 2-2 and 2-4). For low (millivolt) level signal source applications connect the GD terminal to the input cable shield. The other end of the cable shield should be jumpered to the low side of the signal source which should also be grounded (see Figures 2-3 and 2-5).

2.4.2 AC Power Input

Unwind power cable from rear retainer and connect to correct power source.

2.4.3 Remote Chart Drive Control

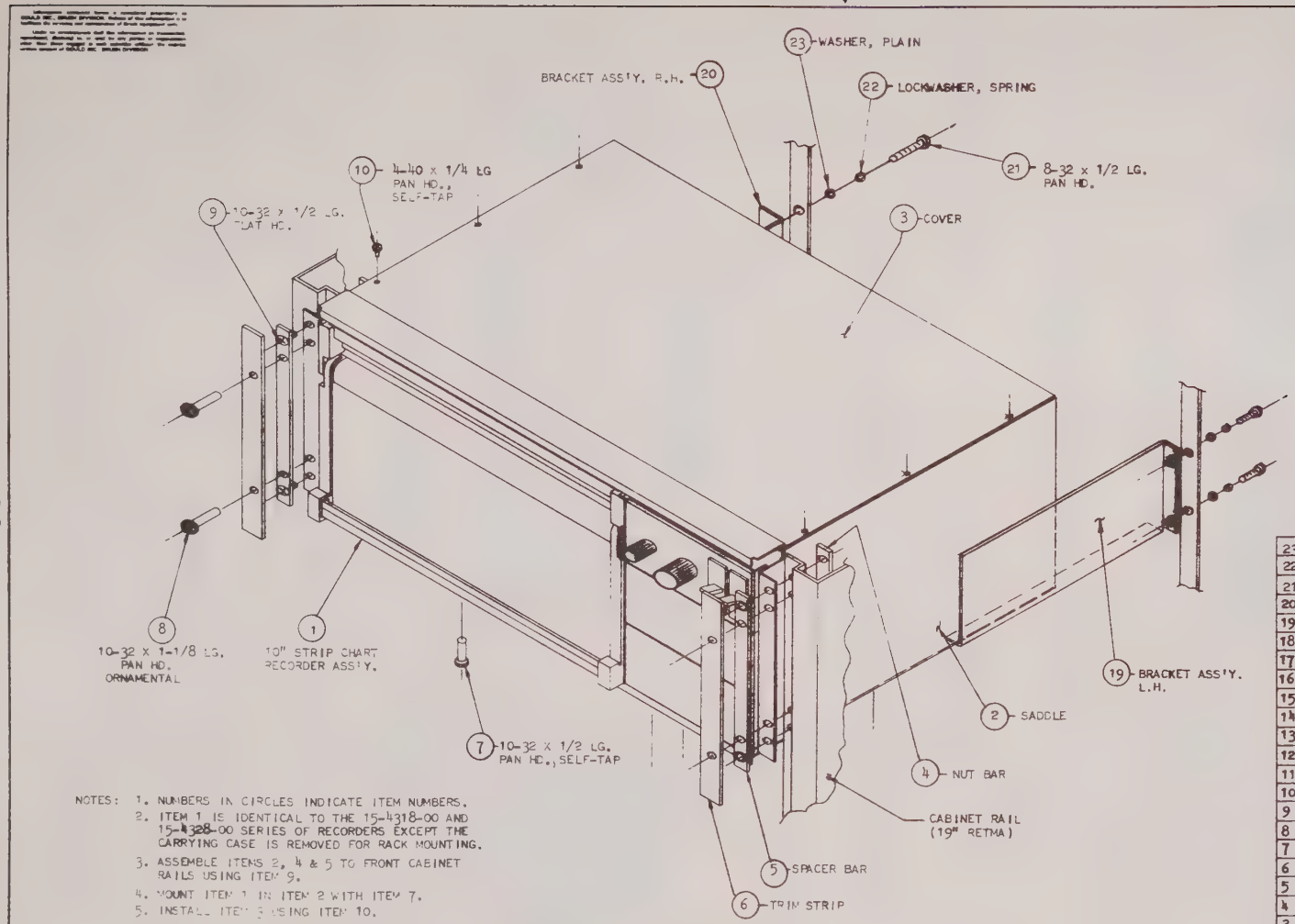
For remote chart drive operation, remove jumper between pins 3 and 4 on rear panel terminal strip (see Figure 3-2). Apply external switch closure to activate chart drive.

2.4.4 External Chart Drive

For external pulse drive, remove jumper between pins 1 and 2 on rear terminal strip (see Figure 3-2). Set chart speed selector on front panel to "R" position. Apply pulse input from appropriate source to terminals 1 and 2.

2.4.5 Options

Options are connected via terminal strips located on the rear panel of the recorder (see Figure 3-2).


23 WASHER, PLAIN
BRACKET ASS'Y, R.H. 20
22 LOCKWASHER, SPRING
21 8-32 x 1/2 LG. PAN HD.
10 4-40 x 1/4 LG PAN HD., SELF-TAP
9 10-32 x 1/2 LG. FLAT HD.
3 COVER
8 10-32 X 1-1/8 LG. PAN HD. ORNAMENTAL
1 10" STRIP CHART RECORDER ASS'Y.
19 BRACKET ASS'Y. L.H.
2 SADDLE
7 10-32 X 1/2 LG. PAN HD., SELF-TAP
4 NUT BAR
CABINET RAIL (19" RETMA)
5 SPACER BAR
6 TRIM STRIP

NOTES:
1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. ITEM 1 IS IDENTICAL TO THE 15-4318-00 AND 15-4328-00 SERIES OF RECORDERS EXCEPT THE CARRYING CASE IS REMOVED FOR RACK MOUNTING.
3. ASSEMBLE ITEMS 2, 4 & 5 TO FRONT CABINET RAILS USING ITEM 9.
4. MOUNT ITEM 1 IN ITEM 2 WITH ITEM 7.
5. INSTALL ITEM 3 USING ITEM 10.
6. INSTALL ITEM 6 USING ITEM 8.

REVISIONS			
DWG.	DESCRIPTION	DATE	APPROVED
A-4	ADDED ITEMS 19 THRU 23. DCN/20714	10/24	

15-4618-16	15-4628-16
15-4618-10	15-4628-10
15-4618-06	15-4628-06
15-4618-00	15-4628-00
APPLICABLE FOR ABOVE MODELS	

NO.	BROWN PART NO.	DESCRIPTION	QTY
	SHIPPING LIST		
23	1-118195-307	WASHER, PLAIN	4
22	1-216741-425	LOCKWASHER, PLAIN	4
21	31-119918-8208	SCREW, PAN HD.	4
20	788041	BRACKET ASS'Y, R.H.	1
19	788043	BRACKET ASS'Y, L.H.	1
18	687001	SHIP. LIST & INSTALL. INST.	1
17	222640	CARD, CONCEALED DAMAGE	1
16	15-804318-00	MANUAL, OPERATING	1
15	422642	ENVELOPE, MANUAL	1
14	283549-1	CORE, PAPER WOUND	1
13	684845	BUSHING ASSY, SUPPLY ROLL	1
12	684844	BUSHING ASS'Y, TAKE-UP	1
11	CABINET	19" RETMA	-
10	13-262716-4004	SCREW, SELF-TAP	6
9	31-119920-0208	SCREW, FLAT HD.	4
8	248352-0218	SCREW, PAN HD.	4
7	13-262716-0208	SCREW, SELF-TAP	4
6	286887	STRIP, TRIM	2
5	286992	BAR, SPACER	2
4	286892	BAR, NUT	2
3	386993	COVER, SADDLE	1
2	386994	SADDLE, RACK MTG.	1
1	SEE MODELS LISTED	RECORDER ASS'Y.	-

DR	L. KISNER	7/1/96	
CH		7/1/96	
APP			

SHIPPING LIST & INSTALLATION INSTRUCTIONS

CODE IDENT 96795

SIZE

CODE

687001

Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.

FIGURE 2-1 SHIPPING LIST AND INSTALLATION INSTRUCTIONS FOR RACK MOUNTED MODELS (687001)

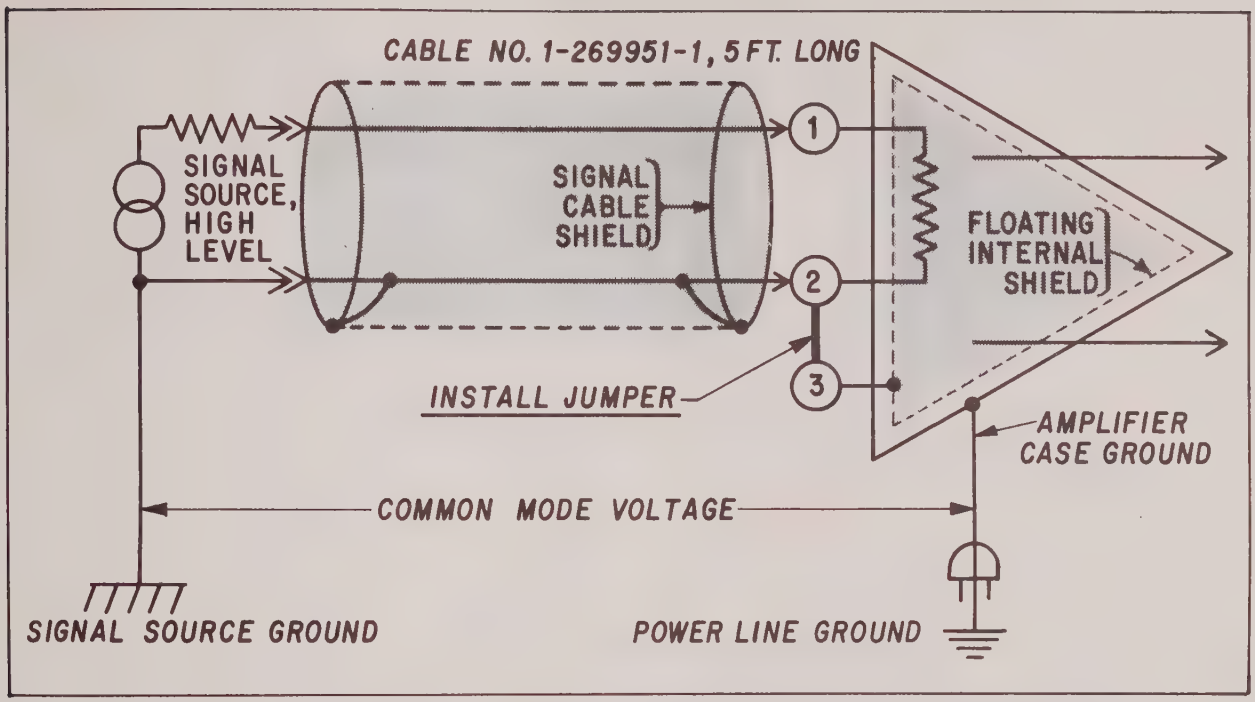


FIGURE 2-2 HIGH LEVEL, GROUNDED, SIGNAL SOURCE

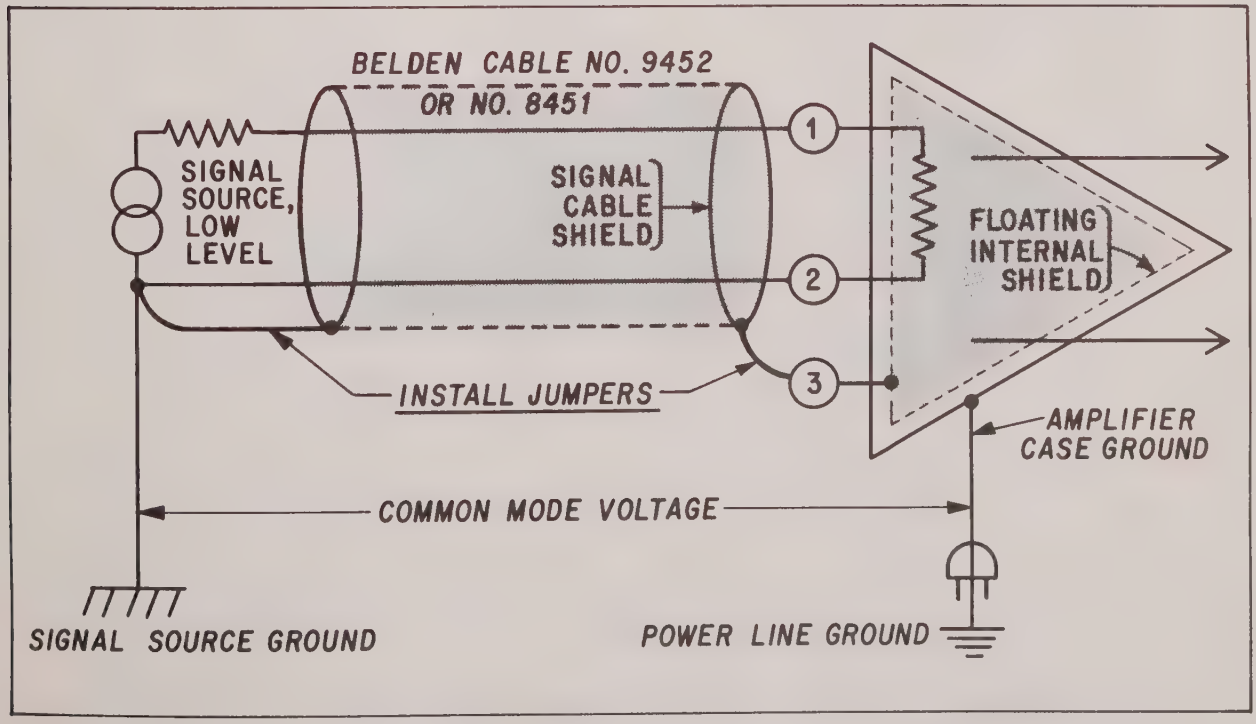


FIGURE 2-3 MILLIVOLT LEVEL, GROUNDED, SIGNAL SOURCE

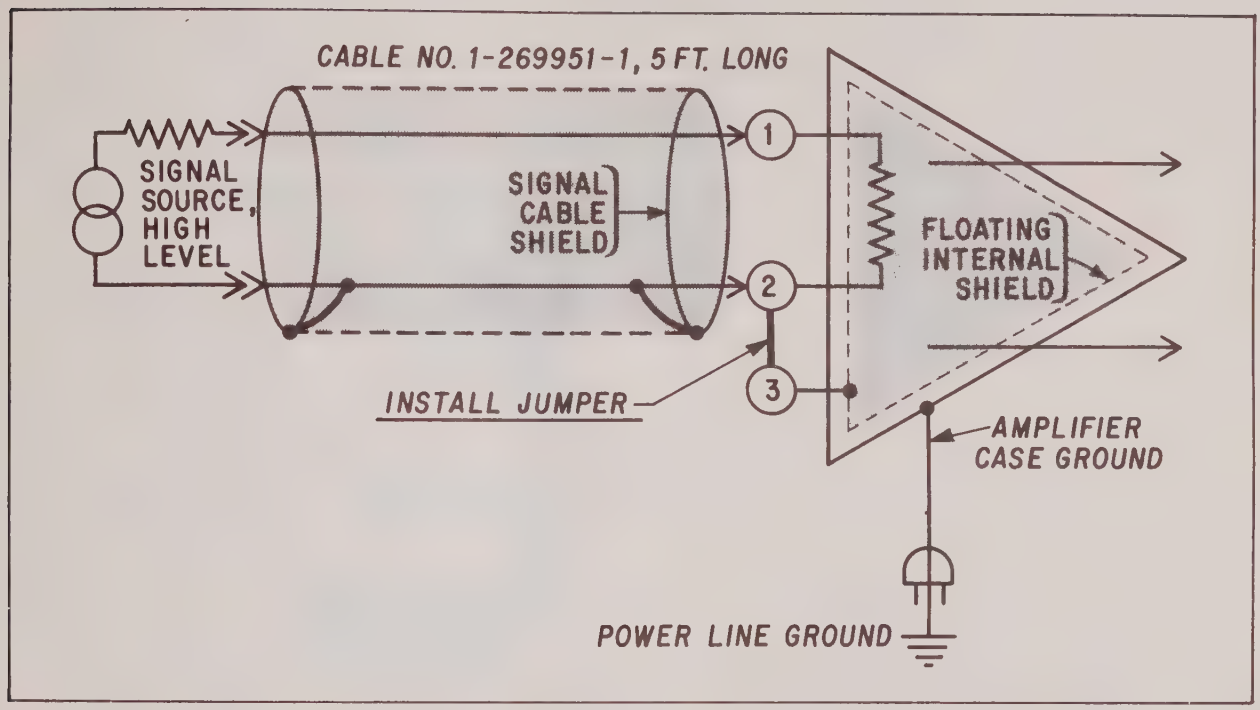


FIGURE 2-4 HIGH LEVEL, FLOATING, SIGNAL SOURCE

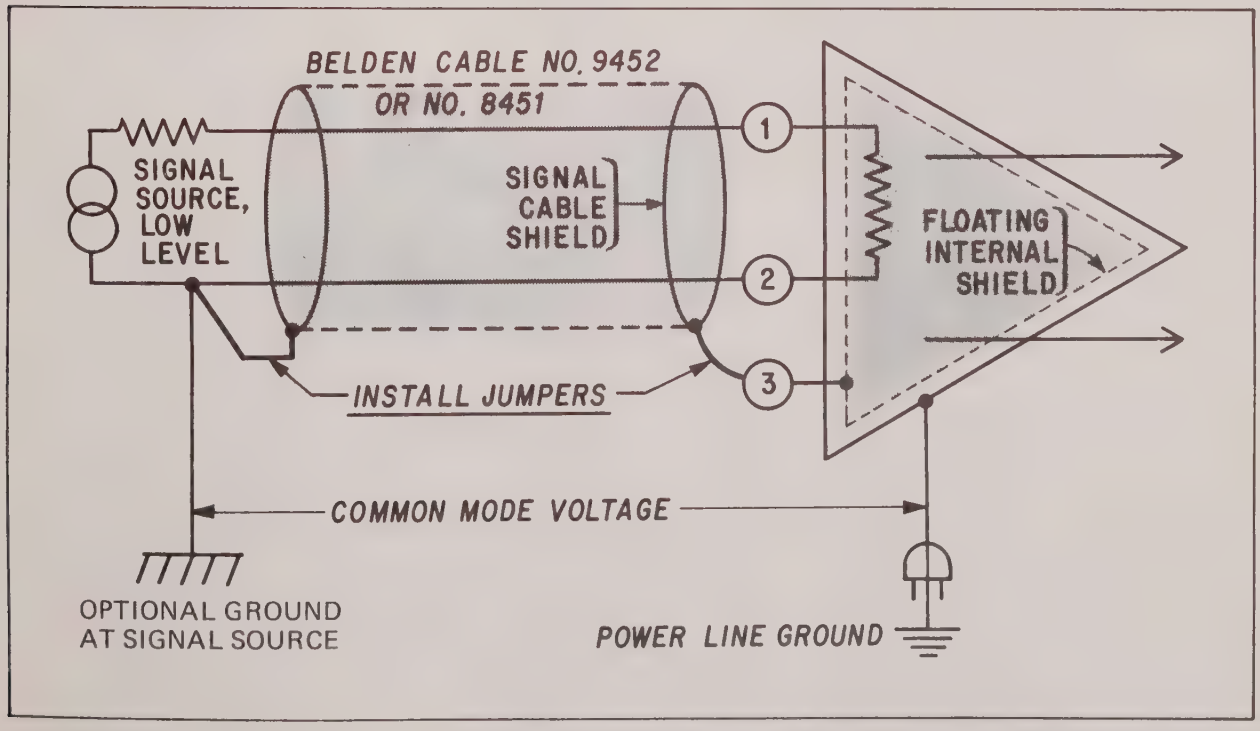


FIGURE 2-5 MILLIVOLT LEVEL, FLOATING SIGNAL SOURCE

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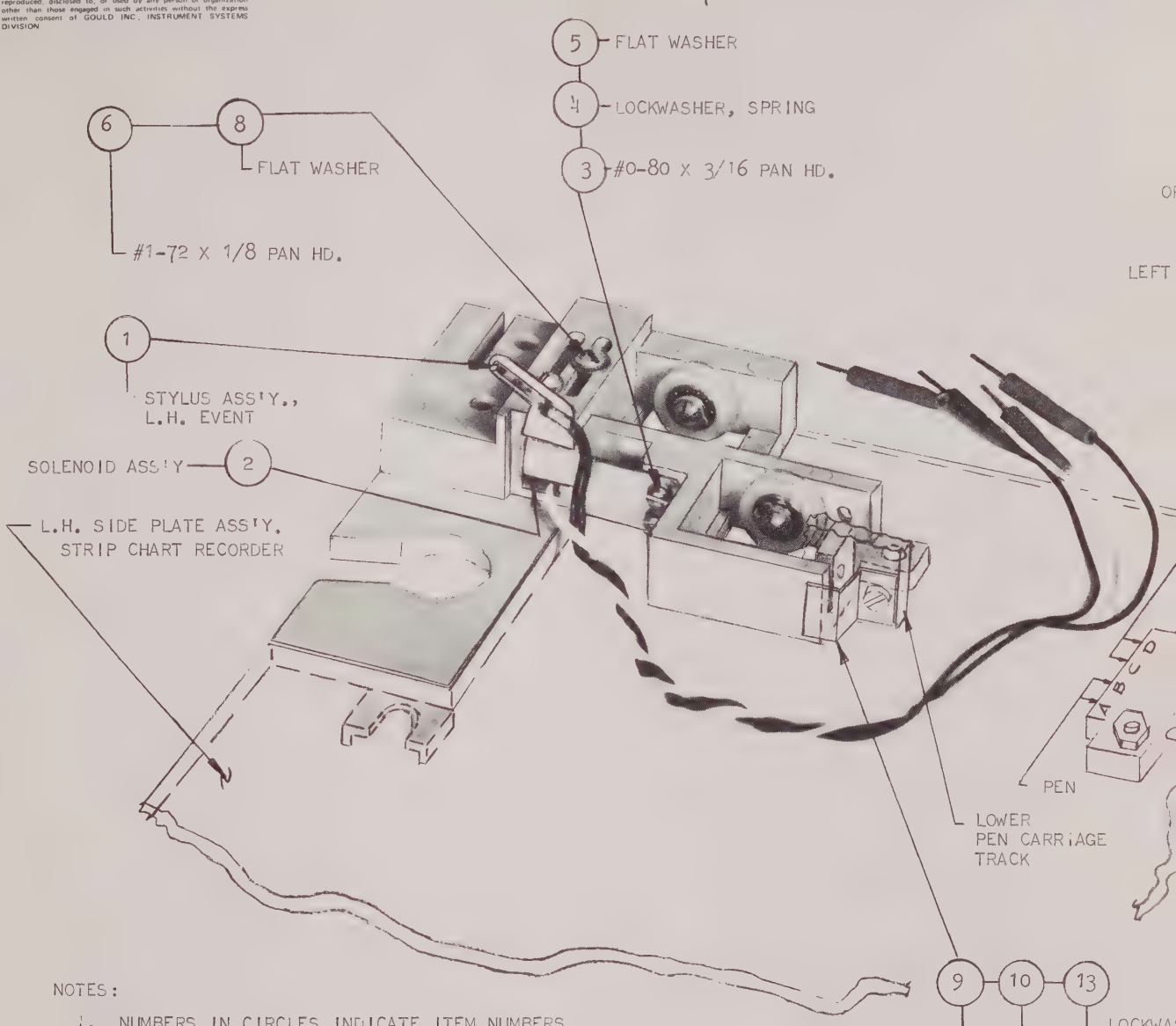
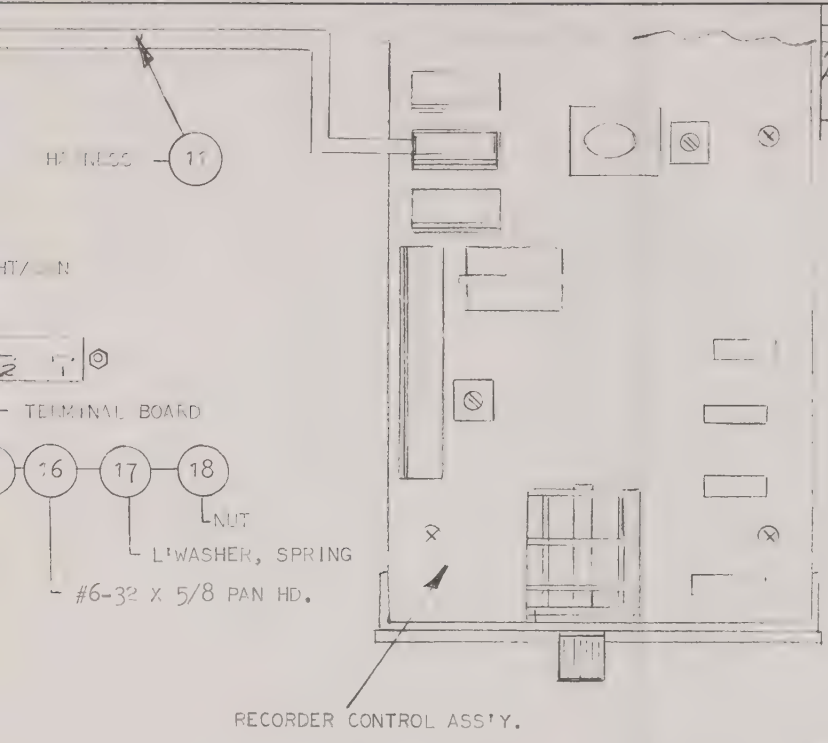
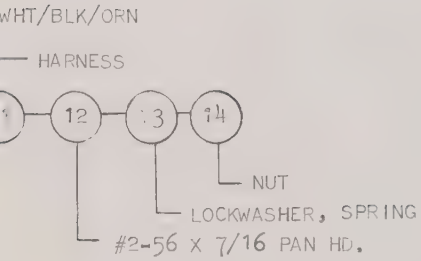


NOTES:

1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. INSTALL ITEM 2 USING ITEMS 6, 7 & 8. TWIST WIRES TOGETHER AS SHOWN, SOLENOID SHOULD BE ADJUSTED TO GIVE APPROX. 20 GRAMS PRESSURE ON PEN WHILE WRITING.
3. INSTALL ITEM 1 USING ITEMS 3, 4 & 5. ADJUST PEN TO WRITE ON THE MARGIN FROM .02 - .07 INCHES BEYOND THE OUTERMOST VERTICAL GRIDLINE. WITH THE SOLENOID DEENERGIZED THE PEN SHOULD REST APPROX. .05 INCHES ABOVE THE WRITING SURFACE.
4. INSTALL ITEM 9 USING ITEMS 10 & 13 AND CAPTIVATE WIRES FROM ITEMS 1 & 2.
5. INSTALL ITEM 11. MOUNT 4 PIN CONNECTOR ON SIDE PLATE AS SHOWN USING ITEMS 12, 13 & 14. ROUTE HARNESS ACROSS REAR OF PEN DRIVE PLATE AND THRU NOTCH IN R.H. SIDE PLATE. CONNECT 6 PIN CONNECTOR ON MAIN CONTROL BOARD AS SHOWN.
6. INSTALL ITEM 15 TO REAR TERMINAL PANEL USING ITEMS 6, 7 & 8. ATTACH INDICATED WIRES FROM HARNESS TO REAR OF TERMINAL BOARD, (CONTACTS MARKED FOR L.H. EVENT) AS SHOWN.

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A-1	ITEM-5 WAS: 1-118195-301		
A-2	ITEM-8 WAS: 11305-21 DCN 20754		





NO	BRUSH PART NO	DESCRIPTION	QUAN
		SHIPPING LIST	
	686747	SHIP. LIST & INSTAL. INST.	1
8	31-119998-62	NUT, HEX.	2
7	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
15	1-286155-[illegible]	BOARD, TERMINAL	1
[illegible]	[illegible]	NUT, HEX.	2
3	[illegible]	LOCKWASHER, SPRING	3
[illegible]	[illegible]	[illegible]	2
[illegible]	286756	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
8	2-[illegible]-202	[illegible]	[illegible]
7			
6	[illegible]	[illegible]	[illegible]
5	285511-1	[illegible]	[illegible]
4	128777-02	LOCKWASHER, SPRING	2
3	31-119911-0003	SCREW, PAN HD.	2
2	281786	SOLENOID ASS'Y.	
1	[illegible]-2874-[illegible]2	STYLUS ASS'Y. L.H.EVENT	

BY	DATE	NAME		
KISNER	9/12/72	SHIPPING LIST & INSTALLATION INSTRUCTIONS	Gould Inc Instrument Systems Division Cleveland Ohio 44114 U.S.A.	
	11/5/74	CODE IDENT 96795	ISSUE CODE G	DWG NO 686747

FIGURE 2-6 LEFT MARGIN EVENT MARKER (11 6222-16)

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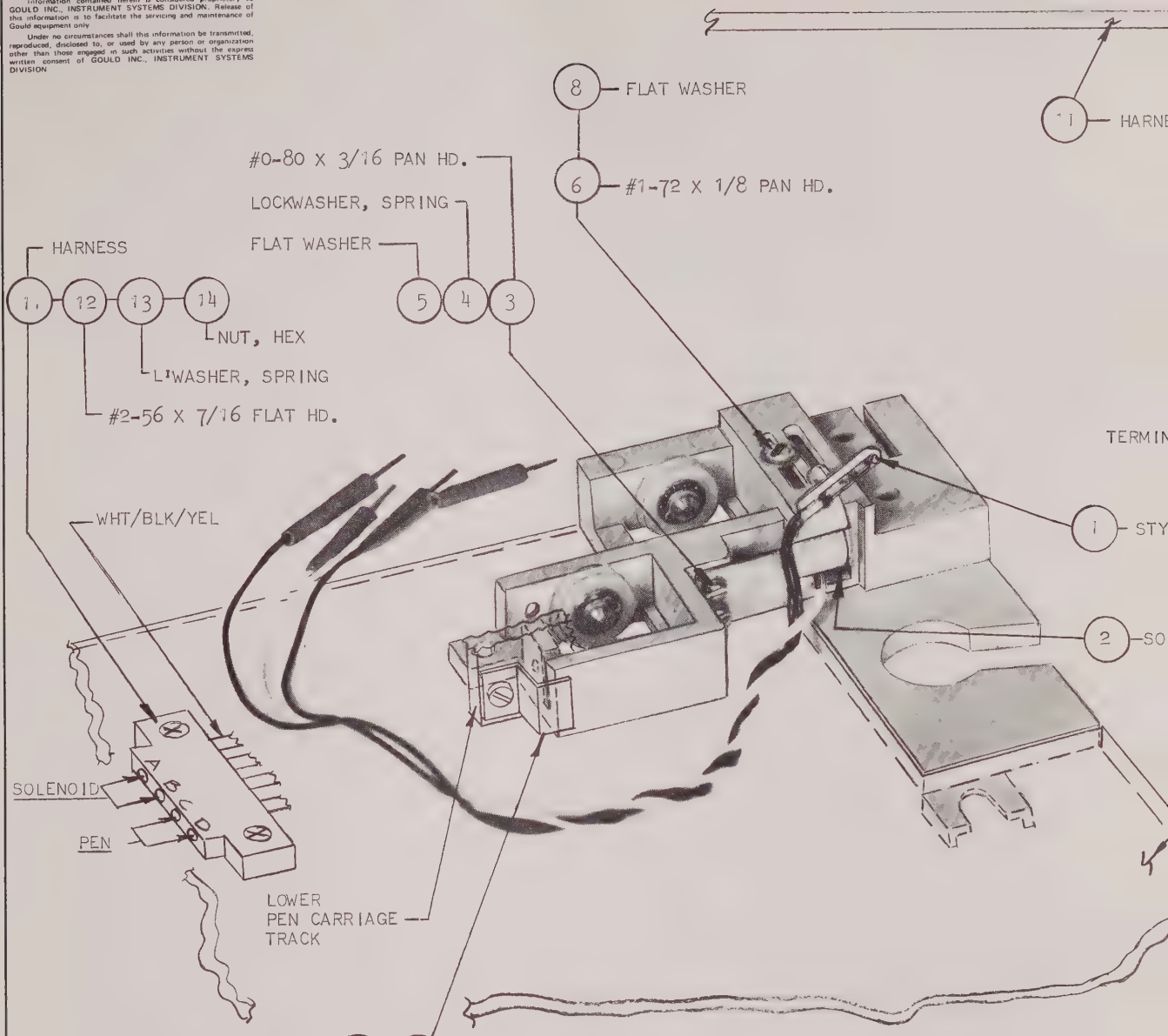
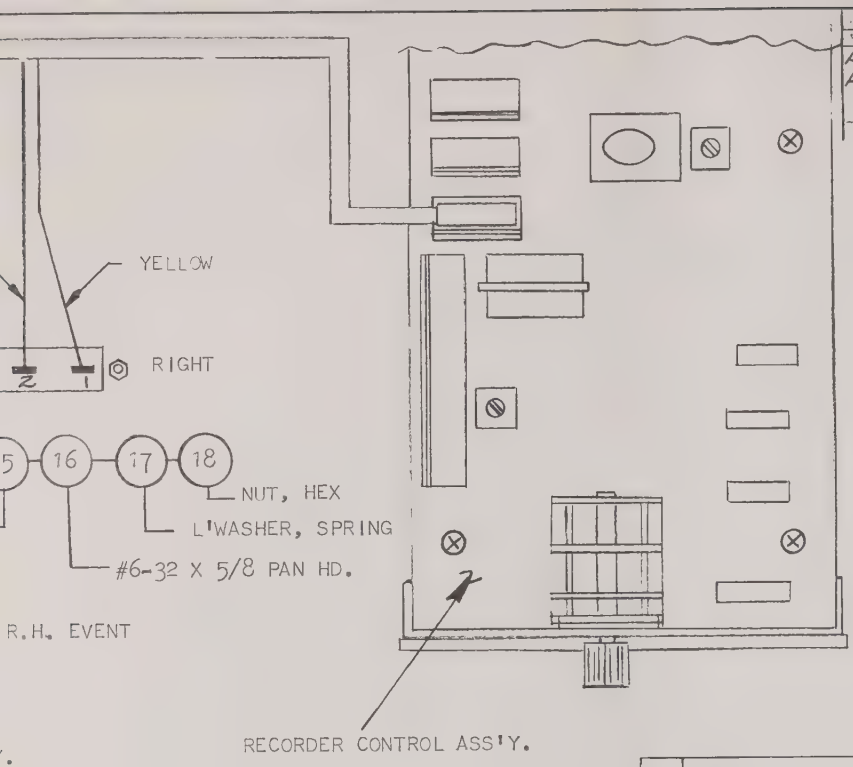


NOTES:

1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. INSTALL ITEM 2 USING ITEMS 6, 7 & 8. TWIST WIRES TOGETHER AS SHOWN. SOLENOID SHOULD BE ADJUSTED TO GIVE APPROX., 20 GRAMS PRESSURE ON PEN WHILE WRITING.
3. INSTALL ITEM 1 USING ITEMS 3, 4 & 5. ADJUST PEN TO WRITE ON THE MARGIN FROM .02 - .07 INCHES BEYOND THE OUTERMOST VERTICAL GRIDLINE. WITH THE SOLENOID DEENERGIZED THE PEN SHOULD REST APPROX. .05 INCHES ABOVE THE WRITING SURFACE.
4. INSTALL ITEM 9 USING ITEMS 10 & 13 AND CAPTIVATE WIRES FROM ITEMS 1 & 2.
5. INSTALL ITEM 11. MOUNT 4 PIN CONNECTOR ON SIDE PLATE AS SHOWN USING ITEMS 12, 13 & 14. ROUTE HARNESS ALONG SIDE PLATE AND THROUGH NOTCH. CONNECT 6 PIN CONNECTOR ON MAIN CONTROL BOARD AS SHOWN.
6. INSTALL ITEM 15 TO REAR TERMINAL PANEL USING ITEMS 16, 17 & 18. ATTACH INDICATED WIRES FROM HARNESS TO REAR OF TERMINAL BOARD, (CONTACTS MARKED FOR R.H. EVENT) AS SHOWN.



REVISIONS			
BY	DESCRIPTION	DATE	APPROVAL
A-1	ITEM-5 WAS: 1-118195-301		
A-2	ITEM-8 WAS: 11305-21 DCN 20754		

R.H. SIDE PLATE ASS'Y.
STRIP CHART RECORDER

NO	BRUSH PART NO	DESCRIPTION	QUAN
20		STRIP CHART RECORDER	-
19	686749	SHIP. LIST & INSTAL. INST.	1
18	31-119998-62	NUT, HEX.	2
17	1-216741-420	LOCKWASHER, SPRING	2
16	31-118818-6210	SCREW, PAN HD.	2
15	1-286155-4	BOARD, TERMINAL	1
14	31-119998-26	NUT, HEX.	2
13	1-216741-402	LOCKWASHER, SPRING	3
12	31-119920-2607	SCREW, FLAT HD.	2
11	886554	HARNESS ASS'Y.	1
10	31-119914-2602	SCREW, PAN HD.	1
9	285103	CLIP	1
8	2-118195-202	WASHER, FLAT	2
7			
6	31-119914-1202	SCREW, PAN HD.	2
5	285511-1	WASHER, FLAT	2
4	128777-102	LOCKWASHER, SPRING	2
3	3 - [illegible]	SCREW, PAN HD.	2
2	281786	SCREW ASS'Y.	1
1	1-287-[illegible]	STY[illegible] ASS'Y, R.H. [illegible]	

SHIPPING LIST

BY	DATE
DR KISNER	9/12/74
CH Guarino	10/15/74
APP [illegible]	10/16/74

NAME: SHIPPING LIST & INSTALLATION INSTRUCTIONS

CODE IDENT: 96795 | SIZE: | CODE: 9

Gould Inc.
Instrument Systems Division
Cleveland Ohio 44114 U.S.A.

DWG NO. 686749

FIGURE 2-7 RIGHT MARGIN EVENT MARKER (11-6222-17)

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the steps necessary to operate the recorder.

3.2 FRONT PANEL CONTROLS AND INDICATORS

Figure 3-1 illustrates the front panel controls and indicators. The following list corresponds to the items called out in the illustration.

ITEM	CONTROL/INDICATOR	DESCRIPTION
1	Balance Control	Balance control enables user to balance integrator unit for minimum drift with zero analog input.
2	Balance Pushbutton	Balance pushbutton overrides chart paper interlock, enabling user to balance integrator unit with writing table removed.
3	Limit Indicator (Upper)	Limit switch indicator provides left and right out-of-limit indications for upper channel.
4	Scale	Upper channel scale.
5	Scale	Lower channel scale.
6	Scale	Integrator pen scale.
7	Span (fixed span)	Plug-in range cards provide 16 fixed sensitivities from 1 millivolt full scale to 100 volts full scale (2 volt full scale card shown), on the fixed span pre-amplifier.
8	TRACE DENSITY	The outer knob controls the pen tip heat for all stylii. The inner control is a fine heat adjustment for the lower channel only.
9	CHART SPEED	Provides "remote" pulse input operation as well as ten chart speeds. CAUTION: WHEN DRIVING CHART FROM AN EXTERNAL PULSE SOURCE, THE EXTERNAL DRIVE OVERRIDES THE END OF CHART SHUT-OFF CIRCUITRY. WHEN PAPER RUNS OUT, THE USER MUST STOP THE CHART DRIVE BY EITHER STOPPING THE EXTERNAL PULSES, OPENING THE REMOTE SWITCH CLOSURE (IF USED), SWITCHING THE CHART SPEED CONTROL OUT OF "R" (REMOTE), OR OPERATING THE CHART STOP CONTROL.
10	CHART STOP	A two-position switch that controls the start/stop chart drive motor.
11	POWER	Two-position switch that controls the on/off prim - ary power to the recorder mainframe plug-in module and options.

ITEM	CONTROL/INDICATOR	DESCRIPTION
12	Signal Connectors	Input signal terminals (fixed gain preamplifier).
13	Signal Connectors	Input signal terminals (multi span preamplifier).
14	OFFSET (fixed span, input signal coupler, and medium gain multi-span)	OFFSET control sets pen zero between ±1 full scale from right hand chart edge on the fixed span preamplifier.
15	−, +, OFF	Three-position switch selects plus, minus, or off for OFFSET control on the multi span preamplifier.
16	OFFSET (high gain multi-span).	Calibrated zero OFFSET up to 10x full scale on the multi span preamplifier. Provides resolution for portions of a signal equivalent to a 100-inch chart.
17	RESPONSE	RESPONSE switch on multi span preamplifier selects FULL (250 millisecond), 0.5, 1, or 2 second response time. Last three positions introduce internal filters with lower cutoff frequencies. Coaxial two-position switch determines whether span sensitivity is volts or millivolts.
18	SPAN (multi-span)	SPAN switch on the multi span preamplifier selects sensitivities of 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, or 100 volts or millivolts full scale. Coaxial vernier control adjusts sensitivity range between attenuator steps.
19	Limit Switches (Upper)	Provides two independent limit switch set points for the upper analog channel.
20	Limit Switches (Lower)	Provides two independent limit switch set points for the lower analog channel.
21	Limit Indicator (Lower)	Limit switch indicator provides left and right out-of-limit indications for lower channel.

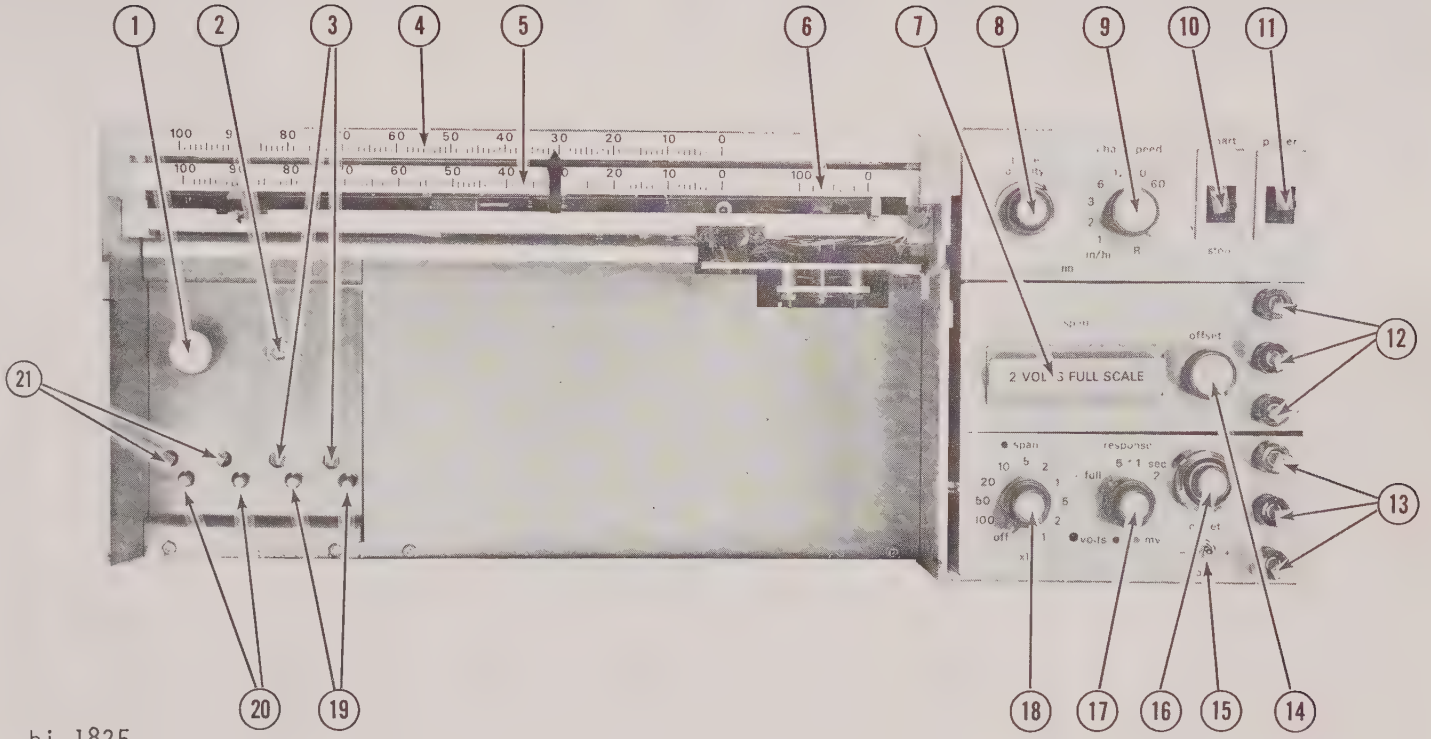


FIGURE 3-1 FRONT PANEL CONTROLS AND INDICATORS

3.3 REAR PANEL CONNECTIONS

Figure 3-2 illustrates the rear panel connections. The following list corresponds to the items called out in the illustration.

ITEM	CONNECTOR	DESCRIPTION
1	Power Cord	Connect to proper ac outlet.
2	Fuse Holder	Contains slow-blow fuse.
3	Retransmitting Potentiometer	Provides connection(s) to optional potentiometer(s) for one or two channels.
4	Limit Switch	Terminal provides connection to internal (front adjustable) upper and lower optional control limit switches.
5	Drive Amplifier	Plug-in drive amplifier boards.
6	EVENT MARKER	Event marker terminals connect to optional right and left hand event markers.
7	Remote Start	Remote start terminals (pins 3 and 4) to actuate the chart drive motor from a remote switch closure (when chart speed is internally selected).
8	PULSE INPUT	Pulse input terminals (pins 1 and 2) for driving chart from external pulse source. CAUTION: SEE NOTE, THIS SECTION, PARAGRAPH 3.2, ITEM 9.
9	Signal Input	Input terminals for single or dual channels may be used in lieu of front panel input terminals on preamplifiers.

3.4 WRITING TABLE

For optimum viewing, the writing table may be positioned at any of three angles: vertical, 15° or 30°. To change from one position to the other, grasp the sides of the writing table and move it to the desired position. To remove writing table, raise table to 90° position and pull out.

3.5 PEN HEAT CONTROL

Trace density is adjusted by rotating the outer TRACE DENSITY knob (see Figure 3-1) until the desired line density is obtained. The smaller inner knob is the trace density vernier and is used when small changes in lower channel trace density are desired.

NOTE: The inner trace density vernier knob may be used to reduce the density of the lower channel trace only.

In model number 15-4328-xx (standard lower channel, plus an upper channel) the density vernier may be used to adjust the density of the lower channel for optimum channel identification.

3.6 SETUP AND OPERATION

3.6.1 General

This section lists the logical sequence of steps necessary to supply signals and operate the recorder. Perform the following procedure:

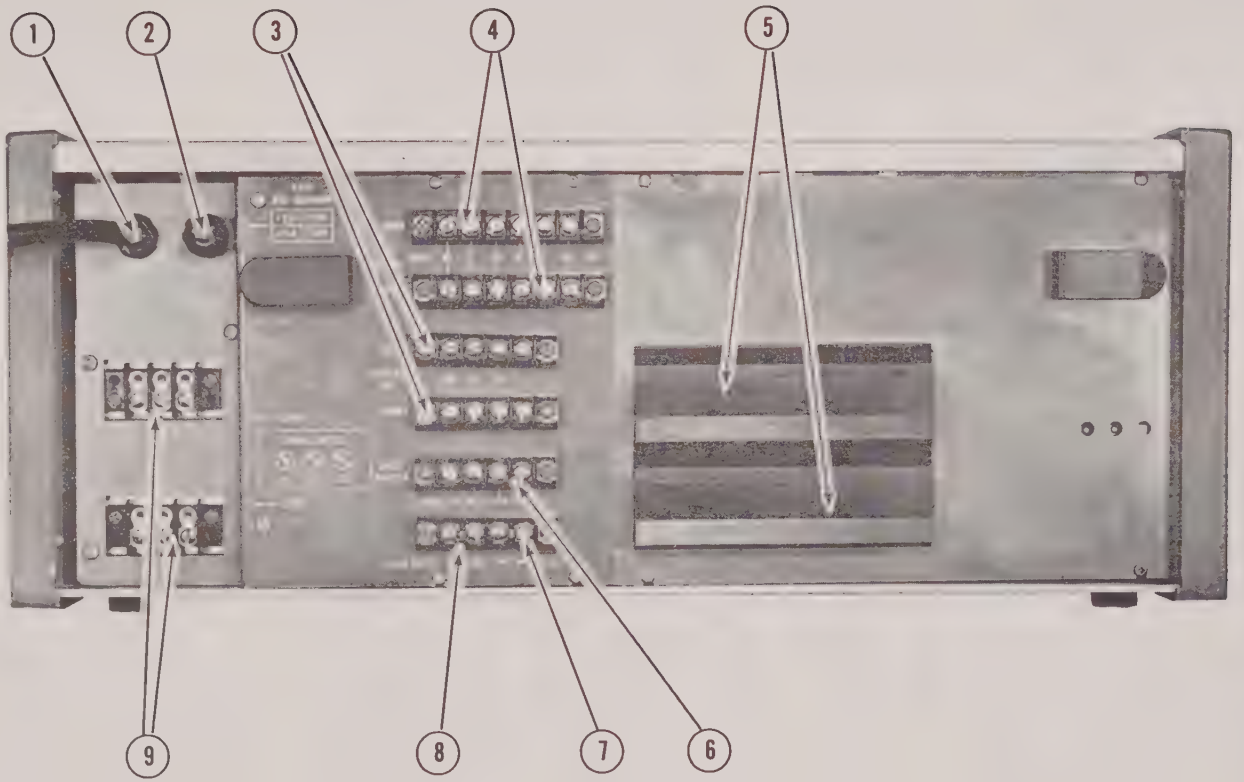


FIGURE 3-2 REAR PANEL CONNECTIONS

CAUTION: BEFORE APPLYING A SIGNAL TO THE RECORDER, VERIFY THAT THE INPUT VOLTAGE DOES NOT EXCEED THE LIMIT FOR THE PREAMPLIFIER USED. SEE SECTION I, FOR PREAMPLIFIER SPECIFICATIONS.

a. Check paper supply level. Make certain an adequate supply is present for length of time recorder is to be operated and that it is properly threaded. See Section VI, chart paper installation, and Section II for checking paper alignment.

b. Make certain that the CHART and POWER switches are off (down).

c. Make electrical connections to the recorder per Section II. Make certain the guard GD terminal is jumpered to the LOW input terminal as described.

d. Place POWER switch in the on (up) position. POWER lamp should illuminate.

e. Obtain a zero input signal as follows:

1. High Gain Multi-Span DC Preamplifier (13-4715-06) — no action required. Multi-Span pen zeroing done in Section VII, Calibration.

2. Fixed Span DC Preamplifier (13-4715-07) — partially remove the range card far enough (about 1") to disconnect it.

3. Input Signal Coupler (13-4715-08) and Medium Gain Multi-Span Preamplifier (13-4715-09)— disconnect the signal wires from the input terminals.

f. Place CHART switch in the start (up) position. CHART lamp should illuminate and chart paper should move.

g. Adjust the OFFSET control(s) to zero the pen(s) at the desired position (Not applicable to High Gain Multi-Span Preamp).

h. Restore the input signal.

j. On the Multi-Span Preamps, set the SPAN, RESPONSE, and OFFSET controls as required for the application.

k. Set CHART SPEED and TRACE DENSITY controls to best display signal.

l. For increased accuracy on the Input Signal Coupler, the TRIM control may be used to precisely calibrate any full-scale sensitivity except the 1 volt range, which is factory set in the pen drive amplifier.

3.7 INTEGRATOR OPERATION

No operator controls are required. Please see Section IV, Theory of Operation, for an explanation of proper usage of this option. Also see Section VII, Calibration, for complete adjustment procedures.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

This section describes the theory of operation, including a circuit description, for both the recorder and its preamplifiers. Figure 4-1 illustrates the basic recorder in block form.

4.2 RECORDER CONTROL ASSEMBLY

4.2.1 General

The recorder control assembly (Figure 4-2) is part of the strip chart recorder mainframe. The assembly (885088) consists of the following circuitry:

AC Distribution
Pen Heat Control
End of Chart
Stepper Motor Chart Drive
115/230 Volt Switching
External Chart Pulse Drive
Event Marker Control
Power Supply

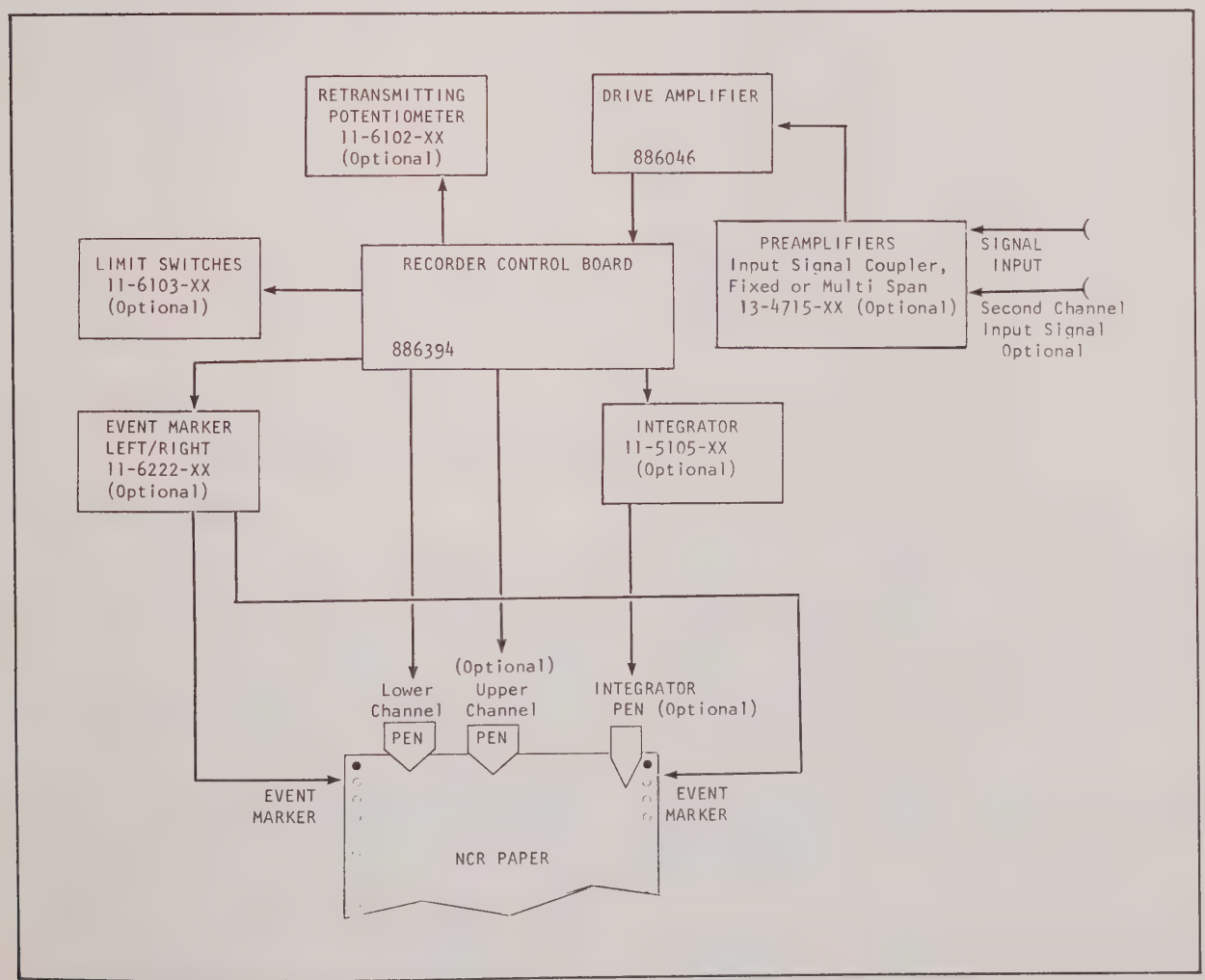


FIGURE 4-1 RECORDER BLOCK DIAGRAM

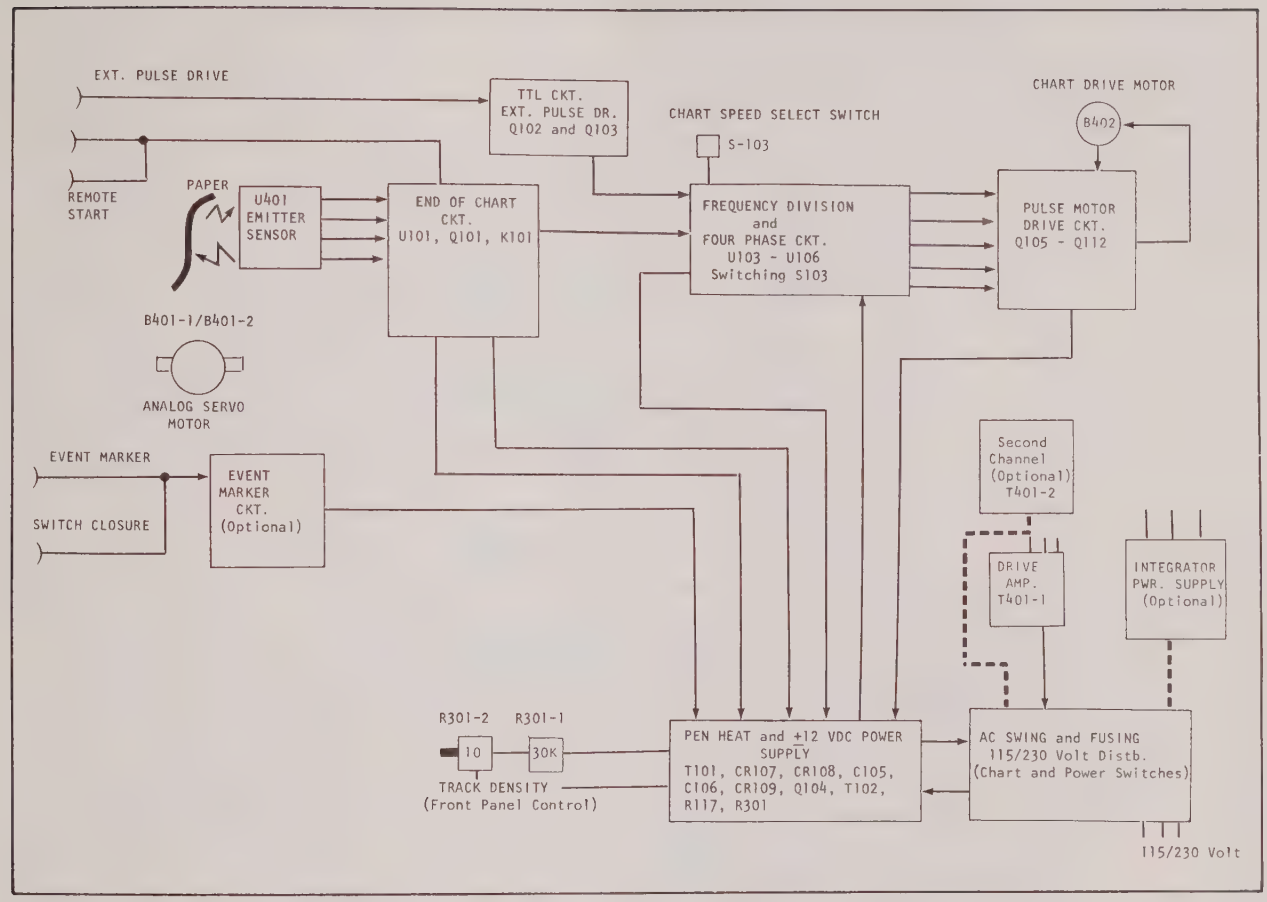


FIGURE 4-2 RECORDER CONTROL ASSEMBLY BLOCK DIAGRAM

4.2.2 AC Distribution

Voltage at the plus corner of CR108 rises, (see Figure 4-3) causing the base two voltage of Q104 to rise. As this is occuring, capacitors C108 and C109 (above 2in/min only-C108 is in the circuit) are charging exponentially. When the emitter voltage reaches the firing point of Q104, capacitors C108 and C109 discharge. The emitter-base-one presents an extremely low impedance at firing point. This current pulse flows through transformer winding T102, light coupler U102 (4N28) and relay contacts K101 to common ground. The current pulse through the primary winding of T102 causes a pulse to flow to the gate-cathode junction of the silicon controlled rectifier CR109. turning it on. The action of turning on CR109, shuts off unijunction Q104, sensing it for the next V2 cycle of line voltage. The delay time before CR109 is turned on is controlled by R301-1 TRACE DENSITY. R301-1 is part of the R in the RC circuit. Resistor R117 is factory set to limit the maximum pen heat voltage. R142 is in parallel with the L.E.D. portion of U102 stopping the half wave sine from modulating. This is accomplished by providing a low impedance path to common ground and allowing only the current pulse to appear across R122 and common ground.

When relay K101 is de-energized, the capacitor discharge path is interrupted. This action prevents the transmission circuit from receiving its timing pulse, causing the chart to stop.

The pen heater voltage may be measured at TP4 and TP5. Use a true RMS volt meter which also responds to DC levels. Capacitor C109 is out of the circuit in chart speeds above 1 in/hr.,thus raising the pen heater voltage in those speeds.

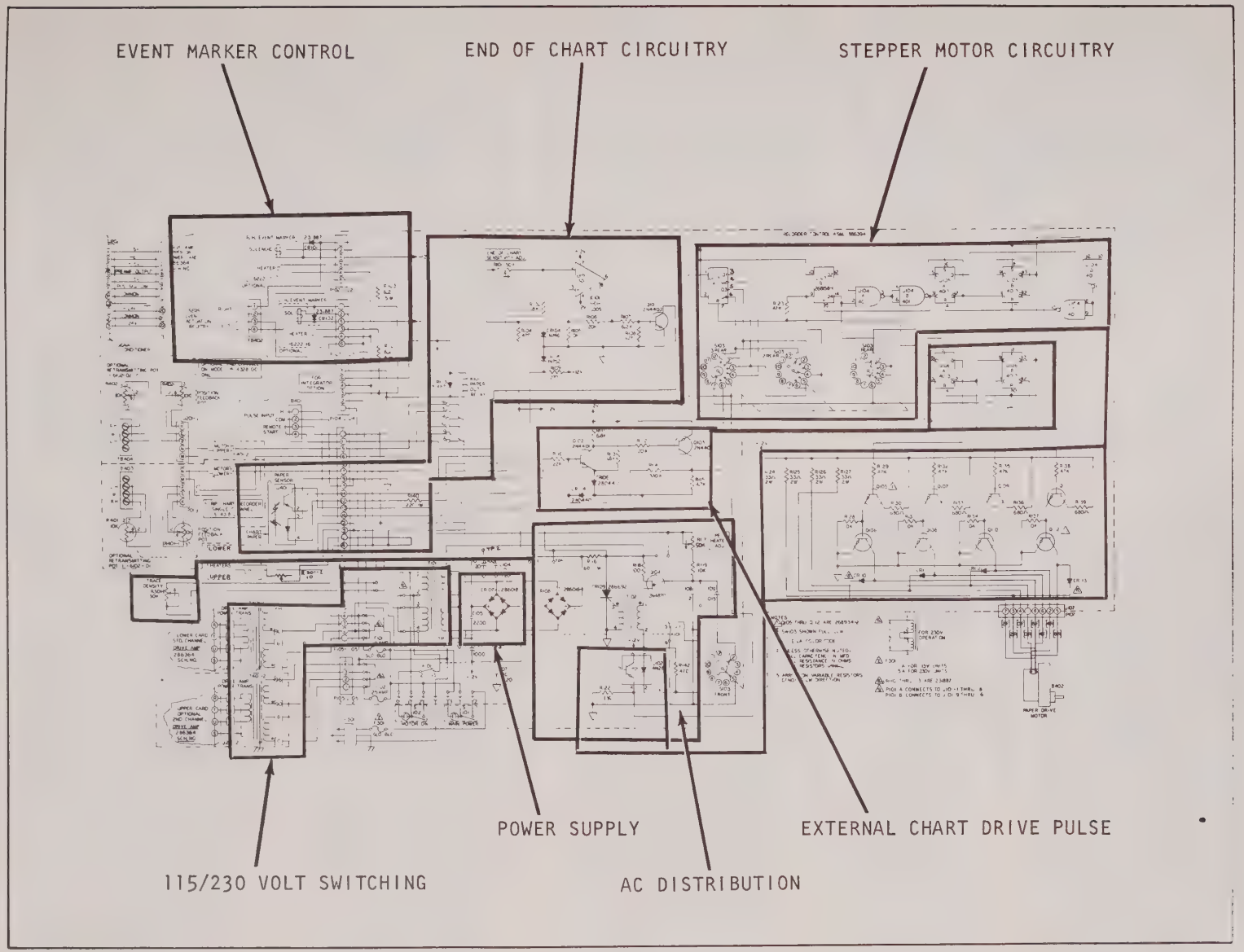


FIGURE 4-3 RECORDER THEORY OF OPERATION DIAGRAM

4.2.3 End of Chart Circuitry

The end of chart circuit (Figure 4-3) employs a led emitter-sensor package (U401) to sense the presence of chart paper or a paper jam condition. When paper runs out, the black anodized drive roll is exposed to U401, causing the voltage at pin 2 (U101) to become more negative. This action causes the output of U101 to become positive, turning off Q101. When Q101 is turned off, relay K101 is de-energized. Relay K101 controls the chart drive and pen heat voltage. When K101 is de-energized and CHART switch is on (up), the chart switch lamp is extinguished indicating a paper jam or paper out condition. Resistor R101 (end of chart sensitivity adjust) adjusts the point where relay K101 energizes, compensating for variations in U401.

CAUTION: WHEN DRIVING CHART FROM AN EXTERNAL PULSE SOURCE, THE EXTERNAL DRIVE OVERRIDES THE END OF CHART SHUT-OFF CIRCUITRY. WHEN PAPER RUNS OUT, THE USER MUST STOP THE CHART DRIVE BY EITHER STOPPING THE EXTERNAL PULSES, OPENING THE REMOTE SWITCH CLOSURE (IF USED), SWITCHING THE CHART SPEED CONTROL OUT OF "R" (REMOTE), OR OPERATING THE CHART STOP CONTROL.

4.2.4 Stepper Motor Circuitry

The CHART SPEED knob on the recorder front panel is connected to the stepper motor circuit. The stepper motor circuit (see Figure 4-3) receives 8.33 or 10 millisecond positive pulses across resistor R122, dividing the frequency to obtain the desired chart speeds. In the fastest chart speed, 8"/min., pulses from U102 (terminal 4) drive the four-phase encoder U106 (A and B) directly without dividing the frequency. The frequency is divided according to the CHART SPEED setting as follows: 4in./min-pulses are divided by two, 2in./min-pulses are divided by four, etc. At setting 1in./hr. (2.50 cm./hr.) pulses are divided by 480, resulting in a pulse every four seconds for a 60Hz line.

Divisions of 2, 4, 8, and 16 are provided by U103 (dual binary up-counter) via R122. U103 and U104 form a divide by ten circuit. U104 is used as an inverter. U104-A functions as a coincidence circuit. U104-DC and U105-A, B constitute a divide by three with U104-D acting as the coincidence circuit. U104-C resets U105 A and B. Output in the slowest chart speed comes from pin 13 of U105-A and goes to S103, position 1 (1in./hr or 2 ½ cm/hr.). Pin six of S103 (rotor) receives front-panel-selected pulses and feeds them to the four-phase encoder. The four outputs from U106-A, B are connected to four pairs of driver transistors, Q105 through Q112. Two of the stepper motors four windings are always energized.

4.2.5 115/230 Volt Switching

The 115/230 volt AC switching (Figure 4-3) is accomplished by jumpers. Transformers T101, T401-1, and T401-2, (T401-2 only when second channel is present) have dual primaries (parallel for 115V and series of 230V ac lines.

4.2.6 External Chart Drive Pulse

When the CHART SPEED selector knob is turned to the "R" position, U106-A and U106-B are driven from Q102 and Q103. Both Q102 and Q103 comprise a Schmidt trigger circuit enabling the external drive signal to be a wide range of shapes (square and sine wave). This circuit is necessary since U106-A and U106-B are positive edge triggered and require a 5 usec., or less time on their inputs.

4.2.7 Event Marker Control

Switch closures at TB402-1, 2 (for right event) and TB402-3, 4 (for left event) cause current to flow through event marker solenoids (see Figure 4-3). This current flow causes the pen-heater assembly to drop down on the paper for as long as the contacts are closed. R141 is the event marker heater dropping resistor. CR101 and CR102 are transient suppressors.

4.2.8 Power Supply

The ±12 volt power supply provides postive voltage to the following circuits; pen heat, step motor drive, event markers, and Schmidt trigger. The end-of-chart circuit and paper out relay (K101) receive -12 volts from the same power supply.

T101 and CR107 (see Figure 4-3) are in a fullwave bridge circuit with C105 and C106 as filter capacitors.

4.3 DRIVE AMPLIFIER

The drive amplifier controls pen positioning and prevents damage to the pen when the input voltage is too great.

The drive amplifier is a servo system using a potentiometer in the feed back loop to control pen positioning. The loop is stabilized by derivitive feedback from the position signal. Figure 4-4 is a schematic drawing illustrating the drive amplifier, including channel power supplies from the preamplifier and other options. Table 4-1 lists the terminal connections for each power supply.

POWER	PIN NUMBERS
+24 volts	13, 15, 20, 22
±15 volts	4, 5, 11, 12, D, E
±6 volts	6, 7, 8, 9, F, H, J, K
Common Terminals	3, 14, 21, C

TABLE 4-1 POWER SUPPLY PIN CONNECTIONS

The input signal is amplified (U204) by a factor of twelve. Current introduced by R221 and R219 condition the input signal so that for a zero to one volt input signal, the output of U204 changes from plus six to minus six volts. When input voltage to U204 is negative, or larger than one volt, the output is limited by the action of U203, CR205, or U204, CR206.

Feedback signals from position potentiometer R401 are monitored by a high input impedance from U209. Output from U209 is used as the position feedback for the servo amplifier. The derivitive of this signal is taken using C212 with amplifiers U208 and U206, which is used as the damping for the servomechanism.

The servo amplifier consists of U207 and a class B power stage (Q205, Q206, Q209, and Q210). The following signals; position, damping, and conditioned input, are summed at the input to the servo amplifier (U207). The servo amplifier drives the motor until the position feedback signal is equal to the conditioned input signal. Diodes CR207 and CR208 conduct when there are large signal variations bringing the gain to 300, independent of frequency. For small signal variations, servo gain acts similar to an integrator with a high DC gain and a corner frequency of 200Hz. In this gain, the high frequency gain also approaches 300.

Removing the writing table de-energizes relay K101, causing the motor and servo amplifier to be disconnected.

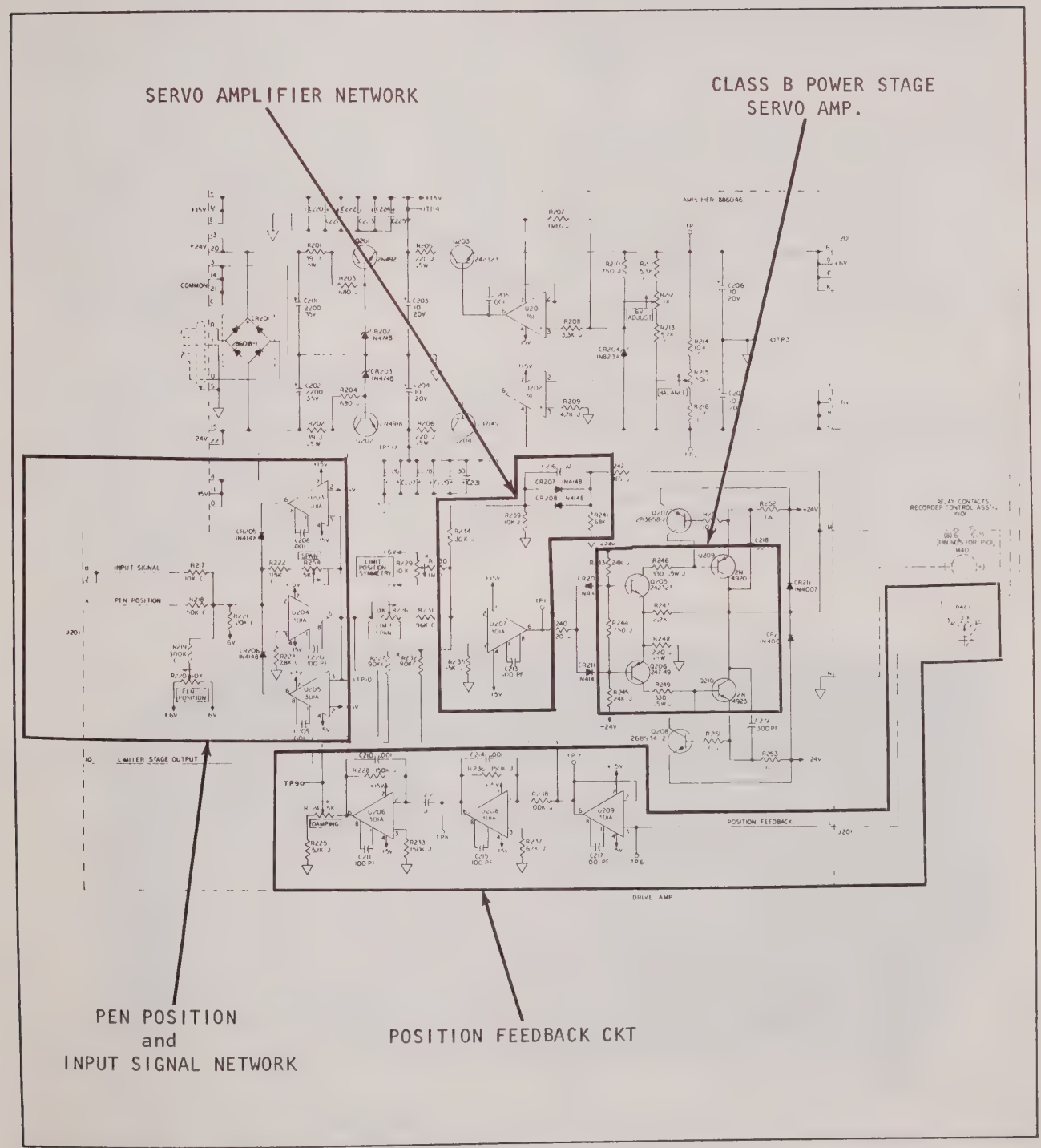


FIGURE 4-4 DRIVE AMPLIFIER THEORY OF OPERATION DIAGRAM

4.4 INTEGRATOR

The integrator is an option that records the area under the curve of the analog input signal. This display occupies a 0.975 inch wide chart strip located to the right of the analog channel display (Figure 4-5). The integrator pen traverses the 0.975 inch chart section once for every volt-second or 100 counts of integration, then reverses its direction for the next segment. Determination of the integral of a complex curve over a given time is a matter of counting the number of full scale excursions plus the partial full scale count. A blip is placed at the excursion every 600 or 1000 counts to aid in count retrieval at slow chart speeds. The blip appears on the up scale peaks for positive integration and on the down scale peaks for negative integration.

The active elements of the integrator are U101-3, C102, R116, and R120 (see Figure 8-30). Operational amplifiers U101-1 and U101-2 provide a signal of opposite polarity which is applied to R116 or R120 as Q101-1 or Q101-2 is turned on or off. When Q101-1 is off and Q101-2 on, the signal from U101-1 drives the integrator by shorting the signal from U101-2 to ground. When a positive voltage is applied to input terminal 14 the output of U101-1 becomes negative, causing the integrator to move in the positive direction. When Q101-1 is on and Q101-2 is off, the integrator input is from U101-2. With the same plus voltage applied to the input (terminal 14) the signal driving the integrator is positive due to U101-2. Operational amplifier U101-2 inverts the signal causing the integrator to move in the negative direction.

The signal which controls Q101-1 and Q101-2 is generated by the comparitor (U101-4). As the output of U101-3 (terminal 8) rises, a point is reached where the voltage at U101-4 (terminal 13) makes a transition from minus to plus. This action causes the output voltage of U101-4 (terminal 14) to rise, switching Q101-1 and Q101-2 to reverse the polarity of integration. The point of transition, or peak voltage of the integrator output wave form is determined by resistors R123, R124, R160 and R161.

When the voltage at U101-3 (terminal 8) reverses, the next transition point is determined by resistors R124, R123, R157 and R163. Note that R157 and R163 were not used in the first sweep. (Q101-3 was held on by U101-4). If the input polarity reverses U102-1 switches, reversing the integrator command signal to U101-4 and resistors R157, R163, R160, and R161.

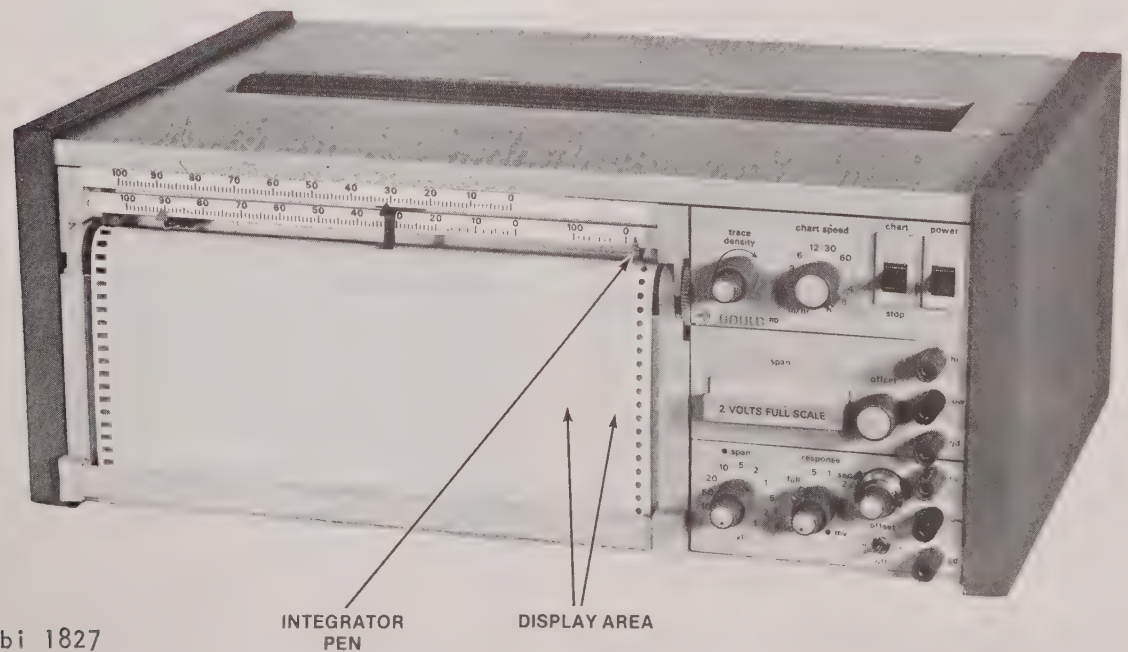


FIGURE 4-5 INTEGRATOR DISPLAY AREA

R155, Polarity sense offset adjust, overcomes the offset voltage of comparitor U102-1 enabling it to switch with less than 1 millivolt change above and below its reference, common term No.5.

The one volt input fullscale time for upscale and downscale integration traverses is calibrated by adjusting the gains of U101-1 and U101-2.

R151, integrator baseline balance, adjusts the integrator drift to minimum by canceling out residual input currents from the preamp and compensating for the offset of U101-1. R151 is initially adjusted at the factory while Q101-1 is off and Q101-2 is on (TP-9 at approximately -4.5 volts) so that U101-2 offset can not influence the integrator drift.

R112, Baseline balance, is used to compensate for resistor tolerance effects and the offset voltage of U101-2. R112 is adjusted with Q101-2 off (TP-9 at +.7 volts). The offset balancing of R151 (above) and R133 must be done in this way so as to get a true balance without one setting influencing the other. R112 is a factory set adjustment which seldom needs further adjustment. The balance adjustments must be made before final Full Scale time Calibration can be made.

U102-2, besides functioning as a precision invertor, is also a buffer amplifier for the integrator signal from U101-3. This buffered integration signal (triangle wave) is summed in R139 and R140. The mid point, terminal 11 of P101, is shorted to common when the paper supply is exhausted. R139 & R140 are integrator signal summing resistors for U102-3, the servo op amp.

TP-2, alternation reversal signal, is used to drive Q101-3 & Q101-4, as described. However, this signal is a square wave whose rise times coincide with the reversals in the integrator triangle wave. This timing signal is used to drive U105, a 4 bit binary counter. The circuit is arranged so that divide by 3 or divide by 5 functions can be switch selected. Since one cycle of this timing signal equals 200 counts, 3 cycles are equal to six hundred counts. This square wave (TEST POINT 8) is capacitively coupled to the normally on base of Q102-3. When the negative transition occurs it turns off Q102-3 for approximately 20 milliseconds. This off time is determined by R-121 and C103. When Q102-3 is off the base of Q102-4 goes to +12V turning Q102-4 on. When this happens the collector of Q102-4, which was at approximately 3.9V, is switched to common for 20 milliseconds. This causes a pip to occur at the peak of the triangle wave (integrator signal).

Since Q102-4 gets its collector supply voltage from the output of U102-1, which is the polarity sense comparitor, the direction of the pips is shifted when the signal polarity changes. The collector voltage of Q102-4 is summed into U102-3 thru R-135.

TP-7 is the drive signal which turns complimentary output pair Q105 or Q106 on or off causing the servo motor to drive one direction or the other. R145 & R146 serve to limit current thru B101.

R134 is the position control for centering the integrator signal in the center of the integrator chart grid. R137, R136 & R138 are voltage division and voltage summing networks for servo position.

Q105 & Q106 common emitters drive servo motor B101. B101 has a 10:1 reduction whose output positions a sector. The position feedback pot, R162, has approximately 12 volts across it. The wiper of the position feedback pot picks up a voltage which is proportional to pen position. This voltage is buffered and amplified by U102-4 which provides high input impedance and adjustable gain. R149, span adjust, controls the gain of U102-4 which determines how far the motor will have to drive the pen before equilibrium is established. Equilibrium is established when the instantanious integrator signal current equals the current which results from the voltage at the output of U102-4 and R142, position feedback summing resistor.

C106, R141 and damping adjust pot R143 allow the pen response to be properly set for constant amplitude. Damping is properly adjusted when the 400% of full scale amplitude is the same as that produced by a 1/10 of full scale signal.

C107 provide for AC feedback while allowing high D.C. gain for accurate positioning of the pen. R144 is a feedback summing resistor for U102-3.

U106 & U107 are positive and negative voltage regulators whose output is + and -12 volts. C109 & C111 are required on the input to the regulators to provide stability. C108 & C110 are for filtering and improved transient reponse, and to reduce interaction between stages.

U108 provides regulated 5 volts for use by the binary divider, U105. C105 provides filtering and improved transient response.

±28 Volts DC come to the main integrator PC Board from a small separate power supply assembly . ±28 volts is used to drive the power stage of the integrator output and also to supply the ±12V regulated and +5 volt regulated supply.

4.5 LIMIT SWITCH

4.5.1 General Description

The limit switch controller is a factory installed option available in either a single or dual channel recorder (single channel 11-6103-01, dual channel 11-6103-02). Each channel control provides two independent switch set points at any desired position on the chart. The limit switch receives its power from the drive amplifier.

4.5.2 Circuit Description (Figure 8-26)

When the pen is positioned at a desired set point, a specific voltage is applied to two noninverting inputs of operational amplifiers, U101 and U102. Position feedback voltage is either positive or negative with respect to the upscale or downscale trip voltages. For example, if the positive feedback is two volts and the voltage set by the "downscale" control is plus one volt, the output of operational amplifier U101 is approximately 13 volts. This action causes Q101 to turn on, energizing relay K101. When relay K101 is energized, it causes light emitting diode CR-105 (panel lamp) to illuminate, indicating a trip condition. Input signal changes cause the output of the operational amplifier U101 to be - 6 volts. This allows Q101 to turn off, de-energizing relay K101 and extinguishing CR105 (down scale "on" lamp).

Operational amplifier U102 and relay switching transistor Q102 perform identical functions as U101 and Q101, with the exception that input conditions are opposite. This is necessary to energize relay K101 with down scale (negative) signals and K102 with up scale (positive) signals. Hysteresis prevents oscillation with very slow rates of change about the relay trip point. Relay contacts are connected to the recorder rear barrier strips.

4.6 INPUT SIGNAL COUPLER

4.6.1 General Description

The input signal coupler (13-4715-08) is designed to be used with a single or dual channel 110 strip chart recorder. This module is installed in the preamplifier enclosure of the recorder. It provides pen positioning and adjustable full scale ranges from 1 volt full scale to 100 volts full scale.

4.6.2 Circuit Description (Figure 8-14)

The input circuit of the pen drive amplifier is an inverting operational amplifier whose function is signal limiting and voltage gain.

The amplifier's summing resistor 108 is 10K ohms and the full scale input voltage is one volt. Resistors added to the summing resistor provide the signal coupler with various increasing full scale voltages up to 100 volts. Full scale voltages are internally selected by inserting a pin jack into the various recepticals on the printed circuit board.

As the full scale voltage increment increases, the input resistance rate (being added to the summing resistor) is 10K ohms per volt. At 100 volts full scale, the input impedance is one megohm.

4.6.3 Front Panel OFFSET Control

Plus and minus 6 volt dc reference voltages are applied to potentiometer R108 with the wiper voltage applied to the drive amplifier via pen position summing resistor R218 (drive amplifier schematic 286364). This enables the user to position the pen anywhere on the chart. Capacitors C101 and C102 filter and decouple the ±6 volt dc reference lines from the preamplifier.

4.6.4 Front Panel TRIM control

This potentiometer adjusts any full-scale sensitivity except the 1-volt range. It is in series with the internal range selection resistors and may be used to compensate for any resistor tolerance build-up. Proper setting of the TRIM control in the range being used results in precise calibration and maximum accuracy.

4.7 FIXED SPAN PREAMPLIFIER

4.7.1 General Description

The fixed span dc preamplifier (13-4715-07) is designed to be used with a single or dual channel 110 strip chart recorder. A block diagram of the preamplifier is illustrated in Figure 4-6. The preamplifier is powered from the drive amplifier power supply in the strip chart recorder. High accuracy at low signal levels is achieved by the use

of a chopper amplifier (U101) which corrects for errors caused by input voltage and current drifts. A front panel OFFSET control (R106) allows the user to position the pen (zero-volt) anywhere on the chart. The input circuit is single ended, floating and guarded, which permits the preamplifier to be operated up to 220 volts DC or peak AC off ground at any sensitivity. The input impedance at sensitivities from 1 millivolt full scale to 100 millivolts full scale is potentiometric and 1 megohm input impedance at sensitivities from 200 millivolts to 100 volts full scale. This high input impedance prevents measurement errors frequently caused by loading the signal source.

Gain modules (11-4601-xx) plug into the preamplifier front panel for rapid full scale span changes. Table 4-2 lists the gain module plug-in cards including input voltage for full scale output.

MODEL NO.	INPUT F.S. VOLTAGE
11-4601-01	.001 volt
11-4601-02	.002 volt
11-4601-03	.005 volt
11-4601-04	.010 volt
11-4601-05	.020 volt
11-4601-06	.050 volt
11-4601-07	0.1 volt
11-4601-08	0.2 volt
11-4601-09	0.5 volt
11-4601-10	1.0 volt
11-4601-11	2.0 volt
11-4601-12	5.0 volt
11-4601-13	10.0 volt
11-4601-14	20.0 volt
11-4601-15	50.0 volt
11-4601-16	100.0 volt

TABLE 4-2 FIXED SPAN GAIN MODULES

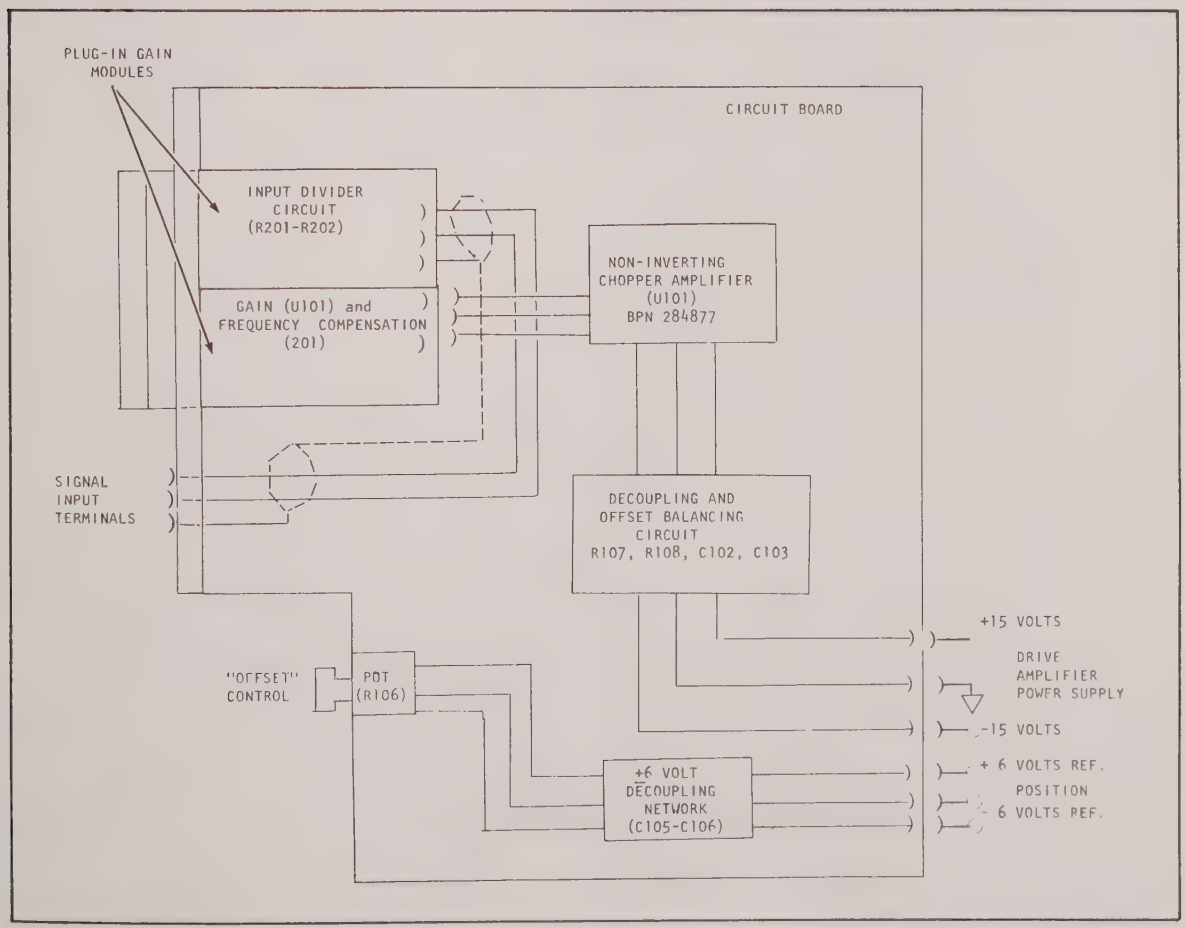


FIGURE 4-6 FIXED SPAN PREAMPLIFIER BLOCK DIAGRAM

4.7.2 Circuit Description (Figure 4-7)

1. Input Circuit

   Capacitor C201 on each plug-in gain module is for frequency compensation. Resistor R203 is in series with R101 (on main amplifier board) and is used in conjunction with zener diodes CR101 and CR102 for over voltage protection.

2. Amplifier Assembly

   Gain modules plug into J101, which is a special shorting card edge connector. An input stabilization, gain, and frequency compensation network is made up of R103, R105, and C104. This circuit prevents instability in U101 when a gain module card is removed (when changing full scale sensitivities). U101 is a noninverting chopper operational amplifier which corrects errors caused by input offset voltage and current drifts.

3. Decoupling Network and Offset Balance

   R108, C102, R107, and C103 provide low frequency decoupling of U101 from the power supply in the drive amplifier. R104 is a factory adjust offset balance adjustment.

4. Front Panel OFFSET Control

   Plus and minus 6 volt dc reference voltages are applied to potentiometer R106 with the wiper voltage applied to the drive amplifier via pen position summing resistor R218 (drive amplifier schematic 286364). This enables the user to position the pen anywhere on the chart. Capacitors C105 and C106 filter and decouple the ±6 volt dc reference lines from the preamplifier.

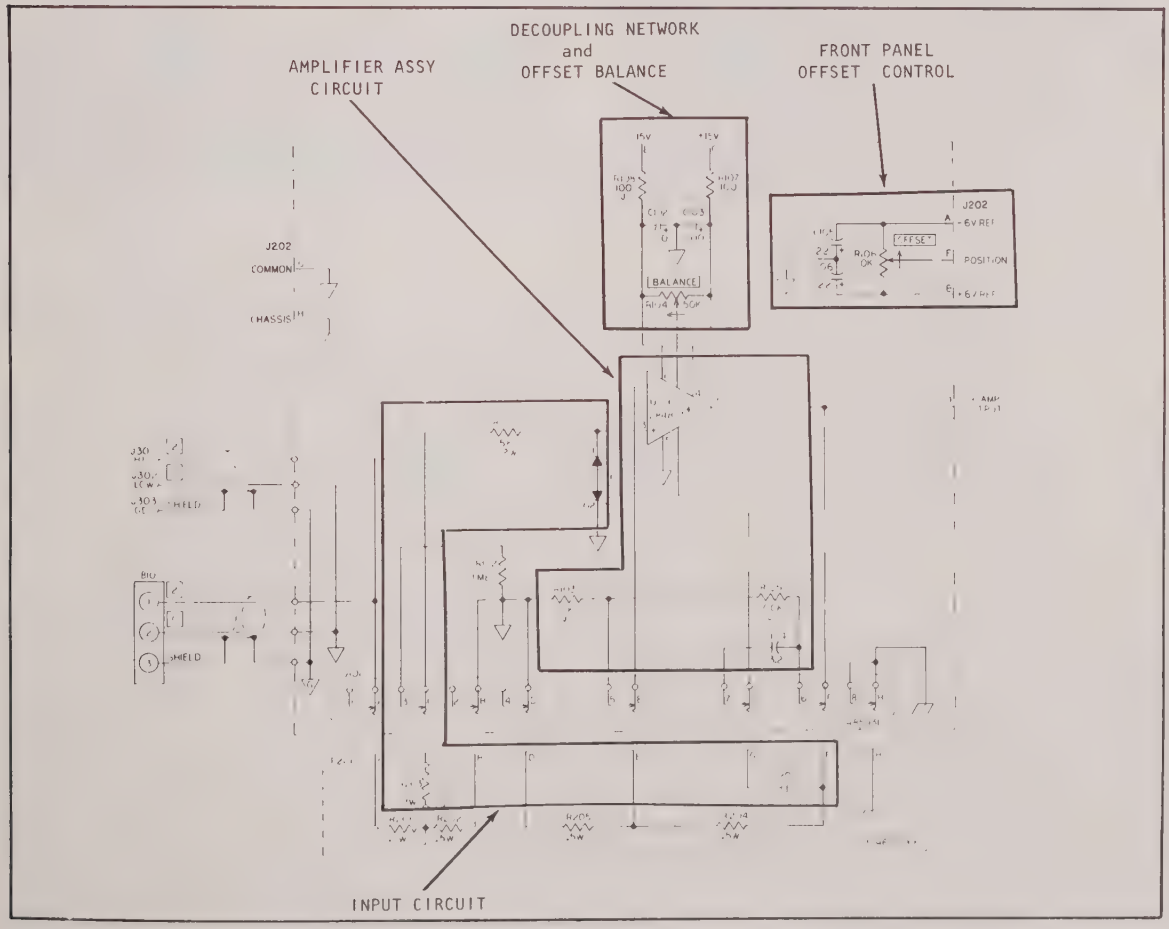


FIGURE 4-7 FIXED SPAN THEORY OF OPERATION DIAGRAM

4.8 HIGH GAIN MULTI SPAN PREAMPLIFIER

4.8.1 General Description

The Multi Span DC Preamplifier (13-4715-06) is designed to be used with a single or dual channel 110 strip chart recorder. The preamplifier is a high precision, high gain preamplifier which uses a chopper amplifier to correct errors introduced by the input offset voltage and current drifts. It is powered from the drive amplifier power supply in the recorder, thus eliminating power supply noise pickup and improving reliability. A calibrated zero OFFSET provides offset up to plus and minus ten times the indicated full scale sensitivity up to the maximum safe input voltage. A calibrated reading, with a resolution of one part per thousand, is provided. This allows the static portion of a complex incoming signal to be offset a known amount and the remaining portion to be displayed for more detailed evaluation.

The input circuit is floating and guarded, which permits this amplifier to be operated up to 220 volts DC or peak AC off ground at any sensitivity. It can be used with signal sources that are grounded, floating, or driven offground without experiencing "ground loops," damaged equipment, or problems normally associated with grounded input circuits.

The input is floating and guarded and provides a potentiometric input impedance in the millivolt mode and a 1-megohm input impedance in the volt mode. This high input impedance prevents measurement errors frequently caused by "loading" the signal source.

Twenty factory-set, fixed gain measurement ranges are provided, plus a variable SPAN control which increases the gain of the amplifier by three times. This permits operation at any point between the fixed gain ranges. A front panel step RESPONSE control S102-A is provided to eliminate unwanted noise while preserving the desired signal. This allows the rise time to be changed from 0.25 second full scale maximum to 0.5, 1 or 2 seconds full scale.

A block diagram of the multi span preamplifier is illustrated in Figure 4-8. The preamplifier consists of the following circuitry: input divider network (S102-B), chopper operational amplifier U101 (with gain ranging network R110), active filter stage (U102), inverter stage (U103), and an offset/output stage (U104).

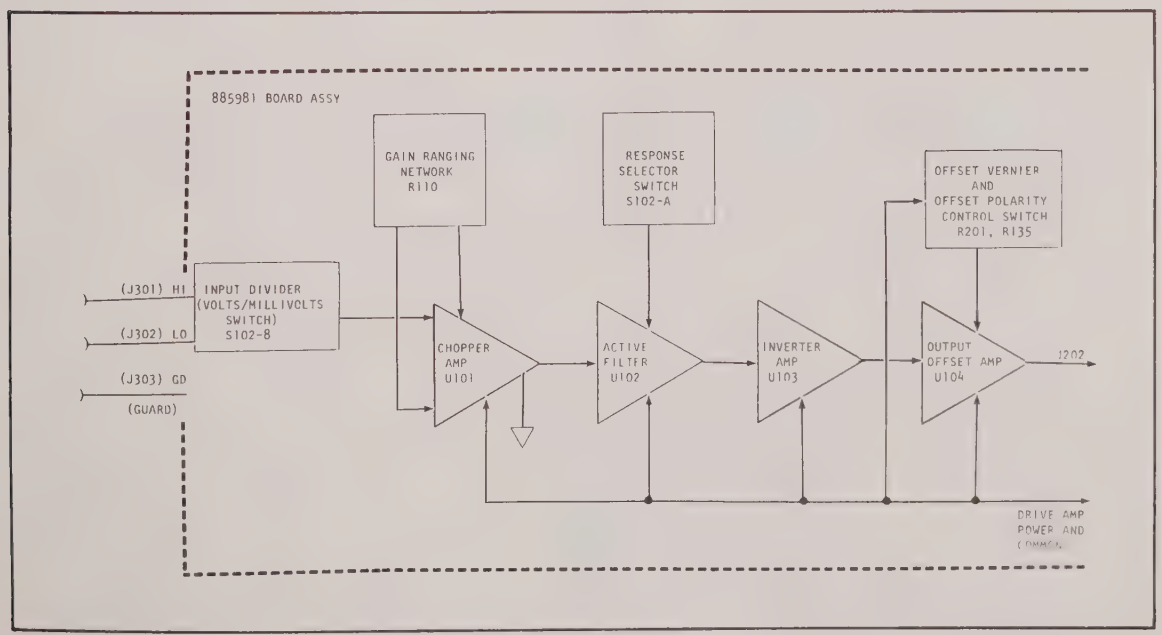


FIGURE 4-8 HIGH GAIN MULTI SPAN PREAMPLIFIER BLOCK DIAGRAM

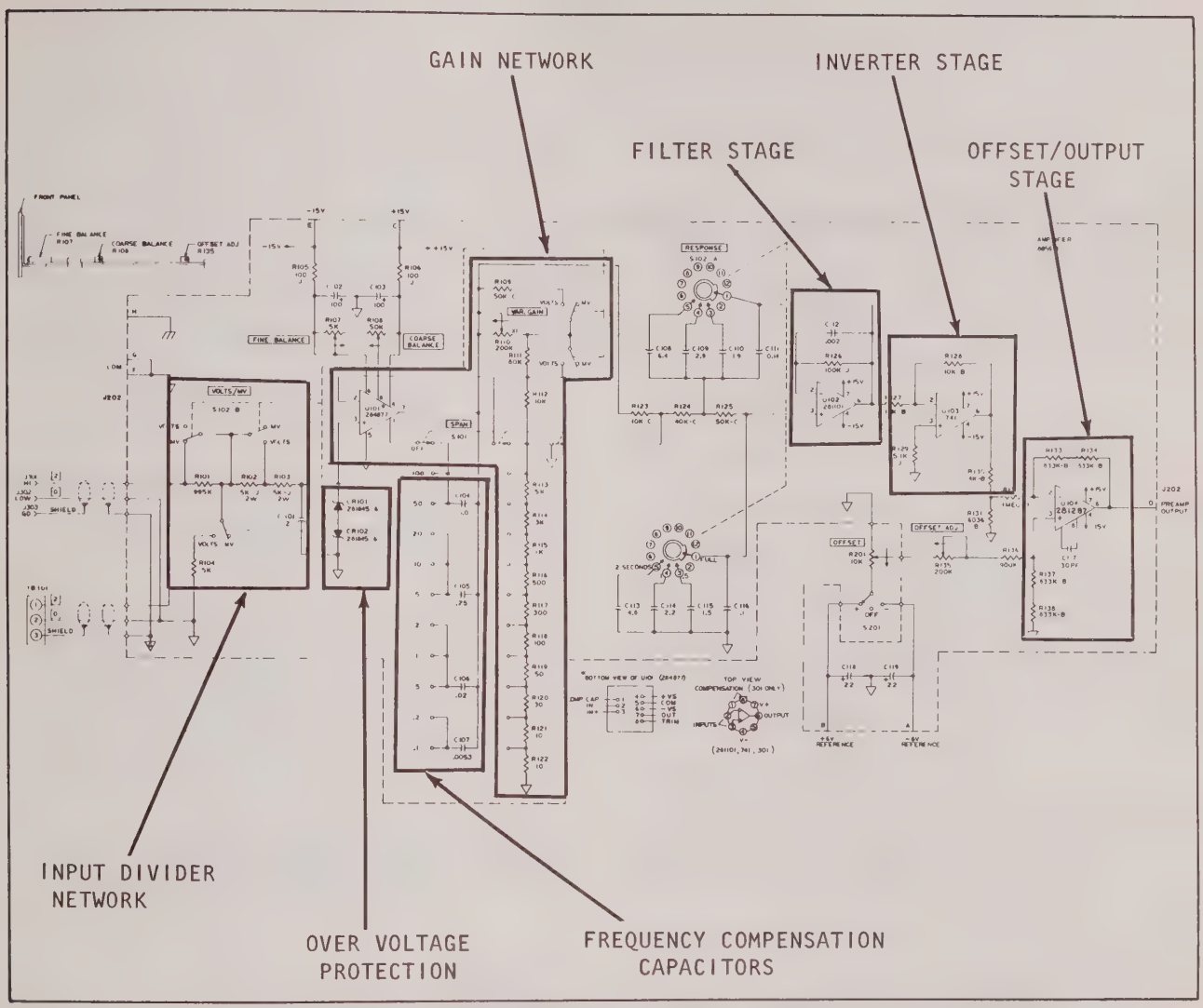


FIGURE 4-9 HIGH GAIN MULTI SPAN THEORY OF OPERATION DIAGRAM

$$E_o = E_s \left(\frac{1 + R_f}{R_i} \right)$$

$$\text{GAIN} = \frac{1 + R_f}{R_i}$$

$$\text{GAIN} = \frac{1 + 19990}{10}$$

$$\text{GAIN} = \frac{19991}{10}$$

GAIN = 1999.1 or 2000

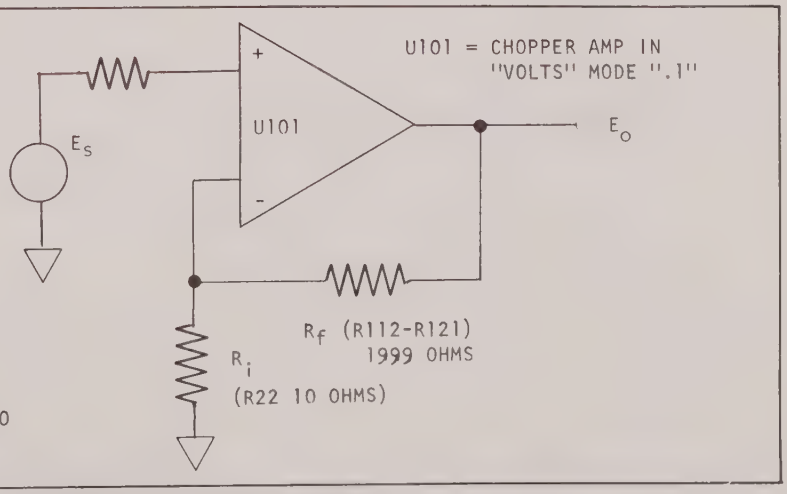


FIGURE 4-10 GAIN FORMULA

4.8.2 Circuit Description (Figure 4-9)

In the "volts" mode setting, resistors R101 and R104 provide a 200:1 division ratio with a one megohm input. For example, when the SPAN switch (S101) is in the ".1" position the gain is 2000. The gain formula and simplified circuit is illustrated in Figure 4-10. The full scale voltage (.1 volt) is 500 microvolts after the input divider (R101 and R104). After amplification, the input voltage is increased to one volt. When R110 (variable gain control) is rotated maximum clockwise, the gain is increased by a factor of 2.66. This available gain change enables the user to obtain any gain between the 1, 2, and 5 span ratios.

Diodes CR101 and CR102 protect the input circuitry of U101 against over voltage. R108 is a course input offset balance and R107 is a fine balance adjustment accessible from the front panel.

In "millivolts" mode, the input divider is out of the circuit and the R_f term in the gain equation is increased by 80K ohms. Gain in the .1 millivolt span position is 9999.1 or 1000. Note that R102 (5K ohms) is switched into the circuit as R104 is switched out, thus keeping the offset shift (due to changing bias current) to a minimum.

Capacitors C104 thorugh C107 are frequency compensation capacitors which keep the -3DB point approximately between 10 and 18Hz.

The filter stage (U102) has a gain of one and provides selectable full scale responses.

The U103 stage functions as an inverter so that the overall amplifier is noninverting.

The offset/output stage (U104) operates at a gain of 1.666. Resistors R130 and R131 are a 1.666:1 divider. U104 operates as a difference amplifier. R201 is a ten turn potentiometer which may be set to cancel-out up to ten full scales of fixed dc offset. R135 is adjustable to obtain "zero" pen positioning with a 10X full scale input, when R201 is in the "10.0" dial setting.

4.9 MEDIUM GAIN MULTI SPAN PREAMPLIFIER

4.9.1 General Description

The 13-4715-09 amplifier consists of an input divider, over voltage protection network, bias current nulling circuit, input amplifier with variable gain and an active filter/output amplifier. Pen position control is also included on the front panel. Power for the amplifier is derived from the model 110 Strip Chart Recorder.

4.9.2 Detailed Circuit Description

See Figure 4-11, Block Diagram and Figure 4-12, Theory of Operation Diagram.

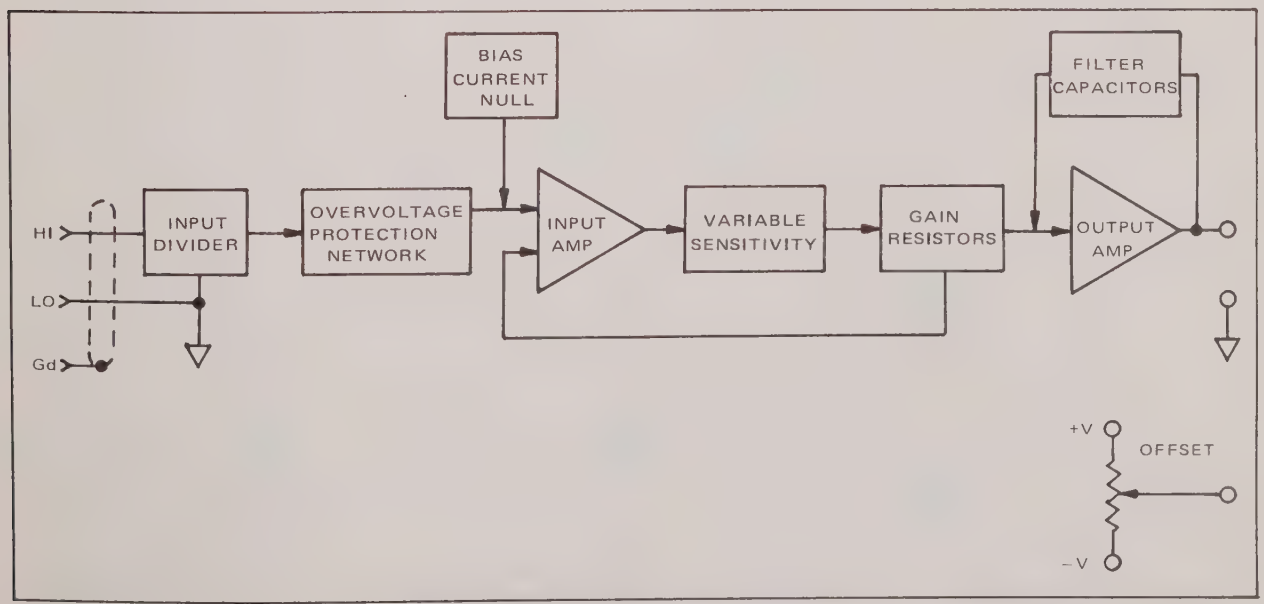


FIGURE 4-11 MEDIUM GAIN MULTI SPAN BLOCK DIAGRAM

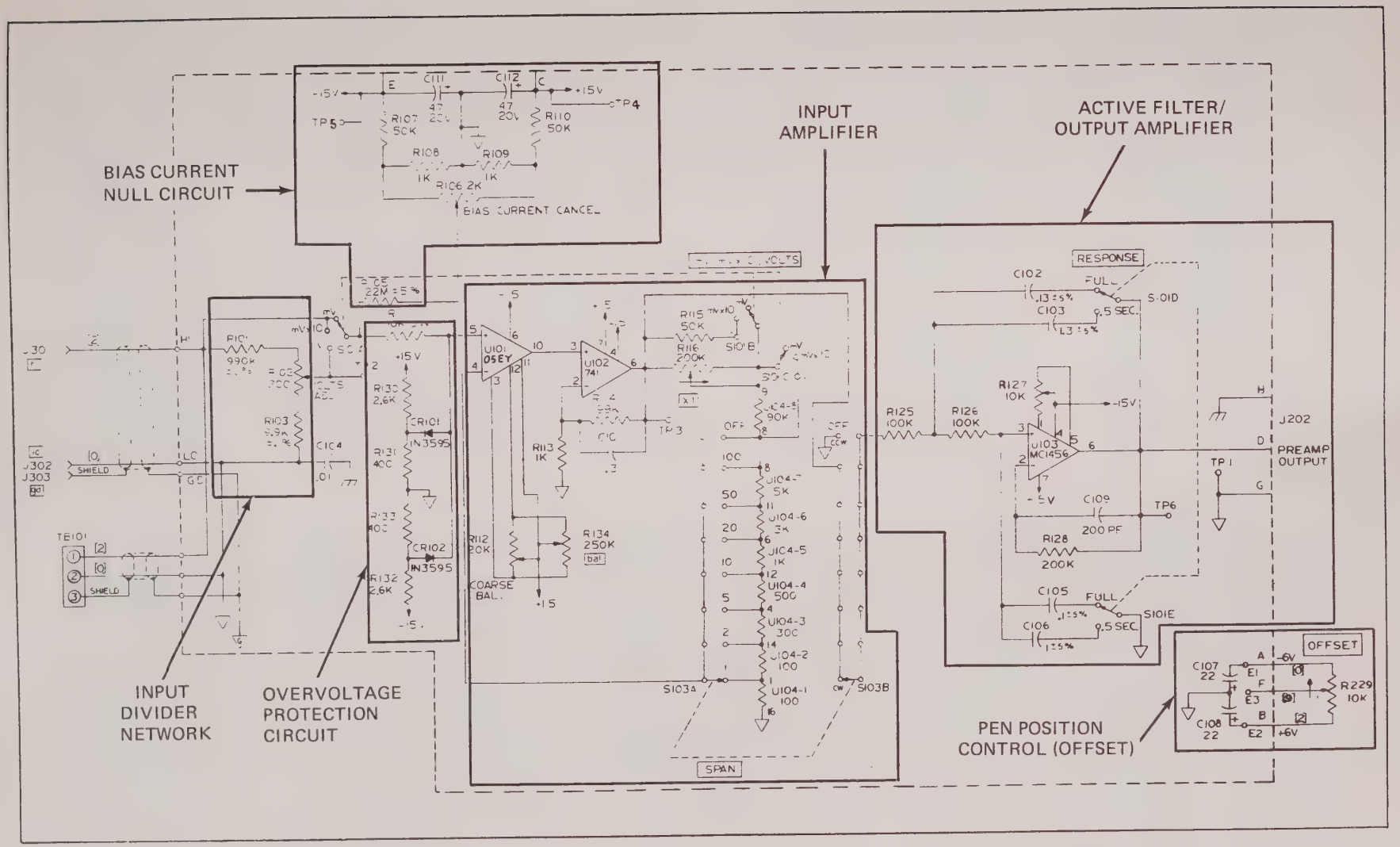


FIGURE 4-12 MEDIUM GAIN MULTI SPAN THEORY OF OPERATION DIAGRAM

1. Input Divider

The input divider is composed of resistors R101, R102 (adjustment), and R103. The input signal either goes directly to the input amplifier in the mv & mvx10 ranges or is attenuated by 100:1 by the divider in the volts ranges. The divider is so arranged that it always presents a constant 1 megohm resistance to the signal source.

2. Bias current null circuit.

Although the bias current of the amplifier is very low (5na max.) it can still cause a significant error when measuring sources with as little as 1K ohm resistance. For instance: 10^3 x 5 x 10^{-9}= 5uv offset which is a .5% error out of 1mv. For this reason a current is injected into the input to partially cancel the bias current. A ten to one improvement is achieved in this manner. The circuit consists of R-105, adjustment pot R106 & voltage dividers R109, R110 & R107, R108.

3. Overvoltage Protection Circuit

Circuits are employed to prevent the input of the amplifier from being damaged by overvoltage. These limit the voltage at the non-inverting input of the opamp to ±10V maximum with up to ±220 volts applied to the input at any sensitivity setting. Diodes CR101 & CR102 are connected to the input and are both reverse biased by 2.0 volts. The diodes are very low leakage types and their contribution to the input offset current is negligible. Under normal conditions the diodes appear to be extremely high resistances (10^9 ohms). However, when the voltage at the input exceeds ±2.0 volts, one or the other of the diodes begins to conduct, and the voltage is limited by the divider action of R111 & R131 or R133. R111 is a 5 watt resistor to withstand the power dissipation during overloads.

4. Input amplifier

The input amplifier consists of two operational amplifiers—U101 & U102. U101 is a low bias current, low voltage drift, low noise amplifier. U102 is lower grade of op amp that is used within the feedback loop to provide gain accuracy. The initial voltage offset is nulled out by potentiometers R112 & R134. R112 is an internal pot which nulls the majority of the offset and R134 is a front panel recessed potentiometer used for more precise resolution.

Sensitivity steps from 1mv f.s. to 100mv f.s. is accomplished by the front panel range switch S103 with the mv, mvx10, v selector switch (S101), set to the mv position. Setting S101 to the mvx10 position shorts out a 90K feedback resistor and changes the sensitivity of the amplifier by a factor of 10. The range then becomes 10mv f.s. to 1 volt f.s. With S101 set to the volts position, in addition to the 90K feedback resistor being shorted out, the input signal is attenuated by 100:1 by the input divider (resistors R101, R102 & R103.) This combination of attenuation & sensitivity change provides ranges from 1v f.s. to 100v f.s.

Continuous adjustment between the fixed sensitivity steps is provided by the front panel gain adjust control, R116. R116 is in series with the feedback resistor string and is shorted out in the CCW detented position. Rotating the control fully CW increases the sensitivity by a minimum of 2.5 on all settings of the attenuator switch S101. R116 is shunted by a 50K ohm resistor in the mvx10 & volts full scale setting of S101 to compensate for the 90K feedback resistor being shorted out.

5. Active filter/output amplifier

U103 is a low bias current, high input impedance operational amplifier. With resistors R125 & R126 and capacitors C102 and C105 or C103 and C106 it is a unity gain, non-inverting, 2 pole Bessel filter. The response time is selectable by the front panel control S101D from .5 sec. (99%) to "full" (70 msec., 99%). In addition to setting the response time of the output, it also acts as a buffer amp to drive the recorder. Potentiometer R127 is used to zero the output of U103.

6. Pen Position Control (Offset)

The pen position control is a front panel mounted, multi-turn pot, R229. The pot is connected between regulated plus and minus 6.0 volt supplies. The wiper of the pot is connected to the recorder and does not affect the zero of the preamplifier.

SECTION V

TROUBLESHOOTING

5.1 GENERAL

This section contains a troubleshooting table to assist the operator/serviceman in locating malfunctions that may occur during normal operation of the recorder.

5.2 TROUBLESHOOTING GUIDE

MALFUNCTION	CAUSE	REMEDY
1. Recorder inoperative	a. Main power not connected to source	a. Connect power to source
	b. POWER on-off switch in "off" position	b. Switch to "on" position
	c. Blown fuse	c. Replace fuse
	d. Open interlock	
	(1) Paper supply exhausted	(1) Install new roll
	(2) Paper magazine not engaged or adjusted properly.	(2) Engage properly
	(3) Chart paper wedged upward and incontact with end-of-chart sensor	(3) Remove writing table and manually roll chart forward about one inch
	e. Defective interlock circuit	e. Repair and/or replace
	f. Defective "on-off" switch	f. Repair and/or replace
2. Chart paper does not drive.	a. POWER switch in "off" position	a. Switch to "on" position
	b. CHART switch in STOP position	b. Switch to "on" position
	c. CHART SPEED switch in R (remote) position with no external pulse source applied	c. Apply drive pulse from external source.
	d. Remote Chart Drive Circuit is open	d. Replace jumper between pins 3 & 4 on rear panel terminal strip Fig. 3-2
	e. Paper magazine improperly engaged	Engage properly and reset interlock
	f. Defective interlock circuit	f. Repair and/or replace

MALFUNCTION	CAUSE	REMEDY
	g. Defective transmission and/or drive belts	g. Replace
	h. Defective drive motor	h. Replace
3. Chart paper speed is not as indicated by chart speed switch, or chart speed does not change as CHART SPEED switch is changed	a. Incorrect line voltage and/or frequency	a. Check for correct line voltage and frequency
	b. Defective CHART SPEED selector switch	b. Repair and/or replace
	c. Defective motor control circuit	c. Repair and/or replace
4. Pen will not travel on line	a. Improper track alignment	a. Re-align track
5. Pen does not move with input signal applied (all chart drive functions operate)	a. Improper input connections	a. Check input connections
	b. Zero OFFSET control is set in incorrect position	b. Disconnect or turn "OFF" input signal & reset zero offset control
	c. Defective signal conditioners	c. Replace and/or repair
	d. Defective drive amplifier	d. Replace and/or repair
	e. Defective cabling, and/or connections	e. Replace and/or repair
	f. Defective pen drive motor.	f. Replace*
	g. Broken pen drive motor mount assembly.	g. Replace*
6. Paper not re-winding on take-up roll	a. Magazine not engaged properly	a. Engage properly
	b. Take-up roll improperly installed	b. Install properly
	c. Tension adjusted improperly	c. Adjust tension

*NOTE: Make certain the pen motor drive belt is sufficiently tight.

MALFUNCTION	CAUSE	REMEDY
7. Paper tears through sprockets when chart drive actuated	a. Chart paper mis-aligned on take-up roll or supply roll core	a. Adjust paper alignment. make sure supply roll is not "telescoped"
	b. Sprocket rollers binding	b. Free rollers CAUTION: IT IS NOT ADVISABLE TO USE LUBRICANT ON ANY OF THE ROLLERS OR DRIVE ASSEMBLIES.
	c. Chart takeup clutch too tight	c. Readjust to 5 inches on torque
8. Pen not writing (Trace skipping or no trace at all)	a. Pen electrically "open".	a. Replace stylus assembly.
	b. Stylus bent	b. Replace stylus assembly.
	c. Pen contact strip P.C. board worn	c. Replace P.C. Board (P/N 485926).
9. Pen vibrates when adjusting OFFSET control on preamplifier.	a. Control (variable resistor) defective or dirty.	a. Replace.
10. Audible oscillations (whistling or howling)	a. Drive Amp power supply circuit Fault.	a. Change C206 on Board 886046 from 10pf to 22pf.
	b. Poor wiper contact in Position Feedback Pot (R401-1 or or R402-1)	b. Tighten contact or replace Pot.
11. Pen Chattering	a. Pen Motor Drive Belt loose.	a. Tighten Drive Belt.

SECTION VI

MAINTENANCE

6.1 GENERAL

This section contains preventive, corrective, replacement and repair maintenance procedures. For major maintenance requirements, contact the nearest Gould Service Representative.

6.2 COVER ASSEMBLY

6.2.1 Removal

a. Turn recorder "off" and disconnect ac power cord from source.

b. Lay recorder on side, remove four screws from bottom of cover assembly and return recorder to upright position.

c. Carefully slide cover assembly forward from recorder.

6.2.2 Installation

a. Carefully slide recorder into cover assembly from the rear.

b. Lay recorder on side and secure cover assembly.

c. Return recorder to its upright position.

d. Connect ac power cord to correct power source.

6.3 CHART PAPER INSTALLATION

a. To remove the writing table, grasp both sides of the "pull bar" and lift upward to the 90° position, then pull outward. (See Figure 6-1).

b. Place the writing table (viewing side down) on a flat surface. (See Figure 6-2)

c. Remove used paper as follows:

(1) Depress end of shaft of take-up bushing assembly (684844) showing through hole in left hand plate assembly (side opposite one with drive belt and pulleys) so that left hand end of paper roll slides out.

(2) When left end clears plate, the entire roll will come out.

d. Remove take-up bushing assembly (684844) from used paper roll and set aside for later use.

e. Remove used, empty cardboard core (283549-1) as follows:

(1) Depress end of shaft of supply roll bushing assembly (684845) showing through hole in left hand plate assembly so that left hand end of cardboard core slides out.

(2) When left end clears plate, the entire cardboard core will come out.

f. Remove supply roll bushing assembly (684-845) from empty core and set aside for later use.

g. Place take-up bushing assembly (684844) from step d. above, in the un-notched end of the empty core.

h. Place the empty core and take-up bushing into the take-up position (where the used paper was) as follows:

(1) Place the notched end of core into take-up roll hub assembly (684847), lining up the notches.

(2) Depress the end of the spring loaded shaft of the take-up bushing assembly (684844) so that the bushing may be slid through the groove into place in the left hand plate.

NOTE: The small "bushing assembly" (684845) is always used on the supply roll.

j. Remove a new roll of writing paper from it's container. Place the supply roll bushing assembly (684845) from step f, above, into the un-notched end of the new roll of paper. (See Figure 6-2)

k. Place the new roll of paper and supply roll bushing into the supply position (where the empty core was) as follows:

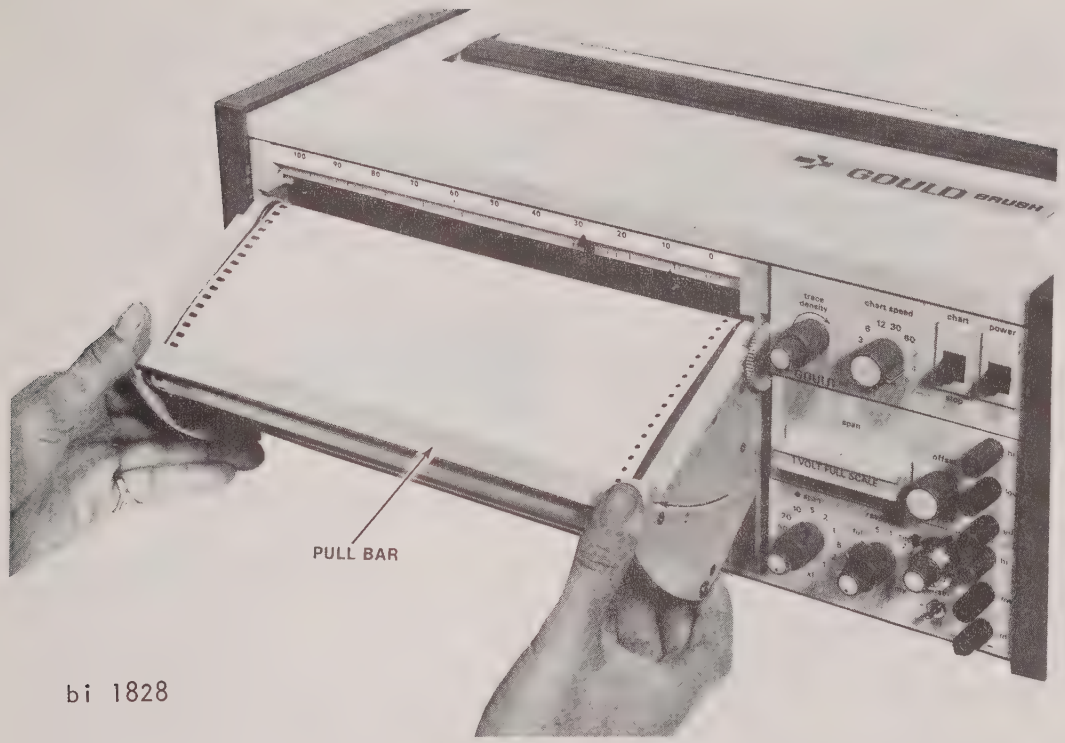


FIGURE 6-1 REMOVING WRITING TABLE

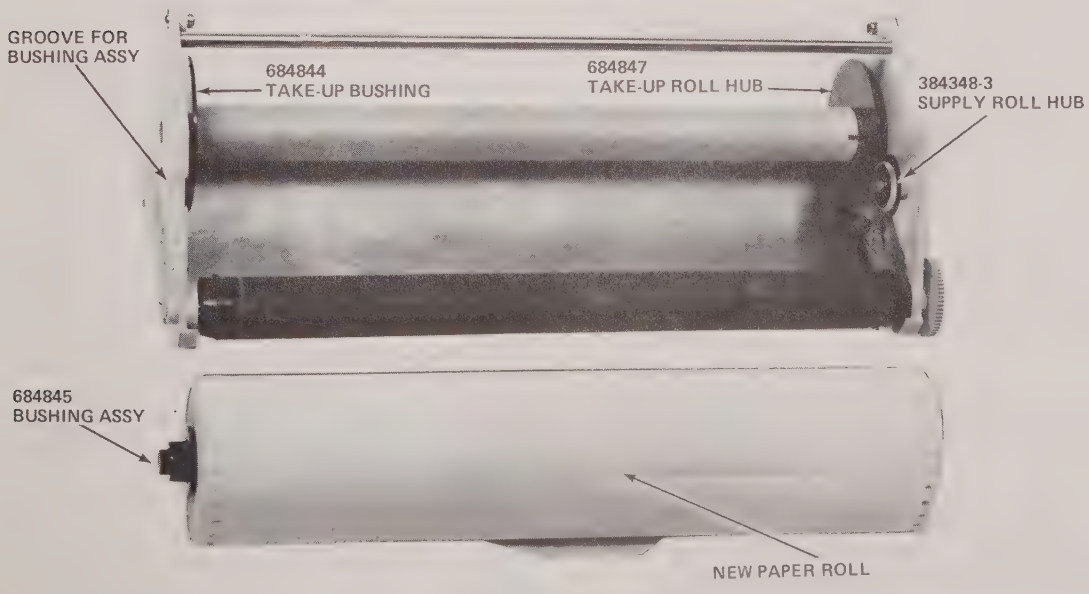


FIGURE 6-2 WRITING TABLE ASSEMBLY

(1) Place the notched end of the new paper roll into the supply roll hub (384348-3), lining up the notches (see Figure 6-3).

(2) Depress the end of the spring loaded shaft of the supply roll bushing (684845) so that the bushing may be slid through the groove into place in the left hand plate.

m. Pull paper under the "drive roller" and over the "pressure roller" (Figure 6-4). Tape the leading edge of the writing paper to the "internal take-up core" illustrated in Figure 6-5.

n. Insert the writing table into the recorder.

6.4 INSTALLATION OF UPPER PEN DRIVE CABLE

1. Remove writing table as previously described.

2. Slide recorder to the rear of cover assembly after removing 4 large screws on bottom.

3. Remove upper scale assembly.

4. Loosen two screws that secure stylus on the top and the screw, washer and spring from under the stylus, remove stylus.

5. Remove broken cable after loosening cable tightening screw on drum assembly, and screw in carriage.

6. Insert new cable thru hole in drum and tie a knot in cable end.

7. Facing the recorder, bring cable to right and in upper slot of drum and thread around the left upper pulley. Thread cable through slot in carriage and through the right upper pulley.

8. Insert screw in top of carriage assembly insuring the cable is positioned in front of screw (½ turn around screw). Thread screw in slightly but do not tighten.

9. Bring cable across to left and in front of drum assembly to lower slot on drum assembly. Take up slack in cable and take one turn around cable tightening screw and tighten screw.

10. Replace stylus and upper scale assembly.

11. Hold the drum assembly firmly with cable tightening screw in the rear while facing unit. Slide carriage assembly as required to position stylus at midscale and tighten the screw in center of carraige to lock position of carriage.

12. Move carriage assembly to left of track and apply 40 $\pm$5 grams to center of cable along track. This should result in a 0.1 inch deflection of cable.

6.5 INSTALLATION OF LOWER PEN DRIVE CABLE

1. The installation of the lower cable is the same as the upper cable except as follows:

a. Remove the upper scale and upper stylus.

b. Loosen the upper carriage assembly by backing off the slotted screw and locknut in center of upper carriage assembly. This allows removal of this carriage assembly from upper track.

c. Remove two screws, washers and black clamping blocks at the ends of the upper track. Remove the upper track and proceed with replacement of lower cable assembly.

6.6 POSITIONING FEEDBACK (VARIABLE) RESISTOR, item 15 or 28,(Figure 8-4)

To install or adjust either of these pots, proceed as follows:

1. Remove writing table as previously described.

2. Remove recorder from cover assembly.

3. Remove drive amp board assemblies (item 18, Figure 8-20).

4. Position drum assembly with cable tightening screw in rear, when facing recorder, and hold in this position.

5. Using an ohmmeter, rotate large body of pot until oriented within 2% of the center of its resistance and secure by tightening the two screws on clamp, item 14, Figure 8-4.

6. Reinstall drive amps, secure recorder in cover assembly and replace writing table assembly.

6.7 LUBRICATION

The pen drive motor(s) No. 284431 (item 24, Figure 8-4), should be lubricated by placing two or three drops of light oil on the outer edge (circumference) of the red, shaft bearing shield disc. This lubrication may be performed whenever other servicing is being done, or as required, to prevent bearing seizure and lengthen motor life.

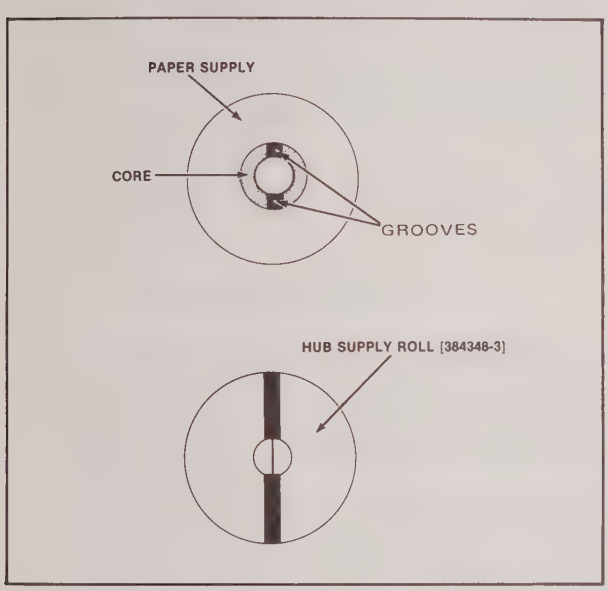


FIGURE 6-3 GROOVES IN PAPER SUPPLY CORE

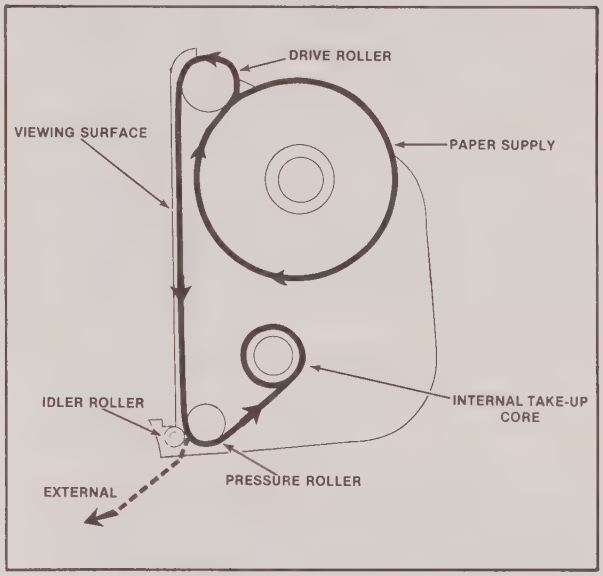


FIGURE 6-4 INSTALLATION DIAGRAM

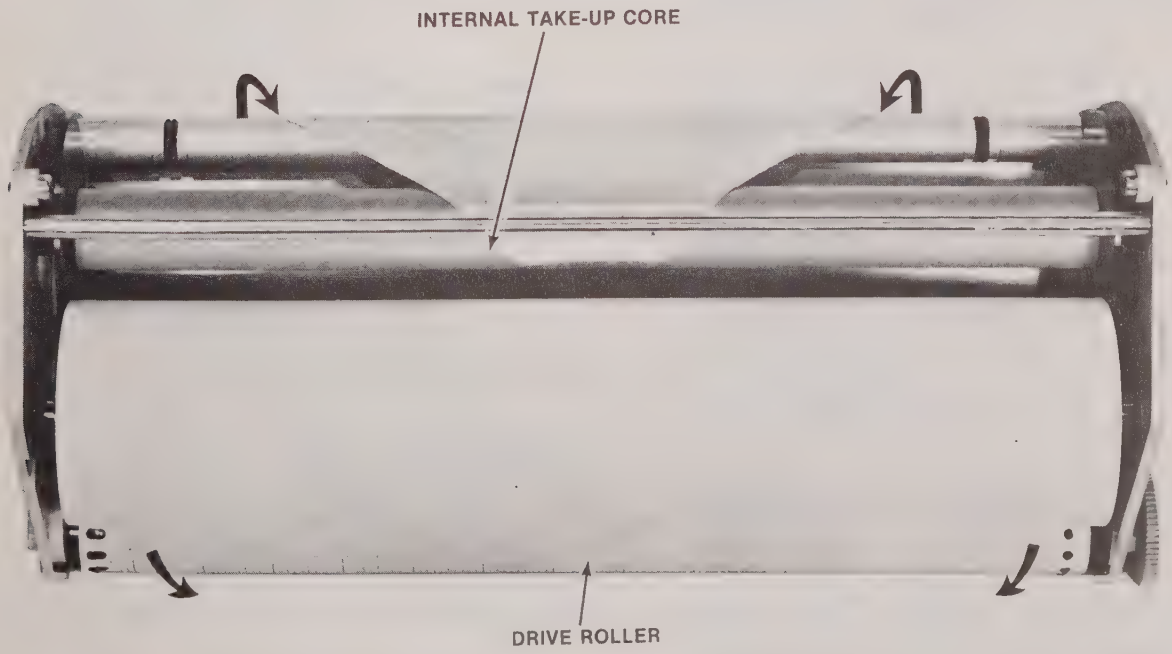


FIGURE 6-5 INTERNAL TAKE-UP

SECTION VII

CALIBRATION

7.1 GENERAL

The Gould 110 strip chart recorder is calibrated at the factory to insure optimum performance. However, calibration may be required when parts are replaced. This section describes and illustrates the procedures necessary to calibrate the recorder, including preamplifiers.

NOTE: Calibration should be performed by qualified individuals.

7.1.1 Test Equipment Required

The following is a list of recommended test equipment for calibration of the recorder.

Oscillograph (Gould 2000 series or equivalent).
Differential voltmeter (Fluke model 8300A, or equivalent).
DC calibration source (Digitec model 311, or equivalent, R_S = 1 ohm or less).
Function generator (Wavetek model 110, or equivalent).
DC responding RMS voltmeter or thermocouple AC voltmeter (Sensitive Research Instruments model USP or equivalent).
Variac-voltmeter (voltmeter accuracy ±2%) and isolation transformer.
Synchronized timing generator
Extension boards (Gould 886604 & 788956)
Frequency Counter .01% accurate. Hewlett Packard model 5245L Electronic Counter with model 5262A time interval unit or equivalent. (used for integrator option only).
Oscilloscope. Tektronix series 530, 540 or 550 with 1A 7A plug in or equivalent.

7.1.2 Preliminary Setup

a. Remove recorder from case and attach to proper power line.

b. Insert main power plug into Variac. Do not turn unit on. Connect ac voltmeter to Variac output.

WARNING: EXPOSED AC LINE VOLTAGE WILL BE PRESENT AT VARIOUS POINTS ON THE UNIT.

c. Remove drive amplifier printed circuit board from the rear of mainframe. Insert extender board (886604) into the drive amplifier location and plug the drive amplifier into the extender board.

d. Short the input terminals to the drive amplifier.

e. Rotate R117 (PEN HEAT ADJUST) counterclockwise (see Figure 7-4).

f. Rotate outer "TRACE DENSITY" knob (located on front panel) counterclockwise. Rotate inner "trace balance" control clockwise. The recorder is ready for calibration checkout.

7.2 INPUT SIGNAL COUPLER (13-4715-08)

7.2.1 Calibration Checkout

a. Insert span pin jack into the TWO VOLT FULL SCALE recepticle. Insert signal coupler into strip chart mainframe. Turn POWER switch on (CHART switch remains off in this step). Allow recorder to warm up for 15 minutes.

b. Connect voltage calibrator to signal coupler input as follows: positive lead of calibrator to HI input and negative lead to LOW input.

c. Set calibration voltage to 0.000. Turn the recorder CHART switch on. Set CHART SPEED to a convenient speed greater than 30 in/hr.

d. Adjust TRACE DENSITY control so that line is visible.

e. Adjust pen position control (R220) on the drive amplifier board (886046) until the trace is on the righthand zero line (if integrator paper 11-2915-12 is used, the zero line is three minor divisions to left of first line).

f. Apply a full scale input signal to the coupler (2.0 volt ±.01%). The pen should deflect 100 (±.25) divisions to the left.

g. Depress CHART switch to stop position and remove coupler. Insert span pin jack into the 100 VOLTS FULL SCALE recepticle.

h. Set calibration voltage to 0.000. Adjust OFFSET control until pen is at the zero chart line.

j. Apply 100 volts (±.01%) to the coupler. Pen should deflect approximately 100 divisions to the left.

k. Adjust TRIM control to obtain exactly 100 divisions of deflection.

l. Remove the 100 volt input calibration signal from the recorder. Pen should return to the zero volt position on the chart.

7.2.2 Offset Operation Checkout

a. Insert span pin jack into the 20 VOLT FULL SCALE recepticle of the amplifier.

b. Insert signal coupler into the recorder mainframe.

c. Switch POWER and CHART controls to the ON position.

d. Set CHART SPEED control to 60 in/hr.

e. Rotate the OFFSET control, moving the pen over its entire range from the left to the righthand limit. (Allow the pen to remain at the righthand limit.)

7.2.3 Full Scale Span Calibration

a. Remove signal coupler and insert span pin jack into the 100 VOLT FULL SCALE recepticle.

b. Insert signal coupler into the recorder mainframe.

c. Connect voltage calibrator to the signal coupler input as follows: positive lead to HI input of coupler and negative lead to LOW input.

d. Apply 100 volts (±.01%) to the coupler input. The pen should deflect approximately 100 divisions.

e. Adjust the TRIM control to obtain exactly 100 divisions of deflection.

f. Remove the 100 volt input calibration signal from the coupler. Pen should return to the zero volt position on the chart.

g. Check the remainder of the full scale sensitivities using the same method described in this subsection.

NOTE: 1 volt position not affected by Trim R-101. Also, Trim R-101 must be adjusted for any given range to give best accuracy.

7.3 FIXED SPAN PREAMPLIFIER (13-4715-07)

7.3.1 Preamplifier Balance

NOTE: Allow the preamplifier to warm up 30 minutes while in the recorder mainframe before adjusting the preamplifier balance potentiometer (R-104)

a. Short the front or rear input terminals to the preamplifier. (This may be accomplished by using a piece of copper wire).

b. Plug the one millivolt gain module (11-4601-01) into the slot in the front of the preamplifier.

c. Connect the differential voltmeter to the preamplifier output terminals (positive lead to pin D terminal and negative lead to pin G terminal). See Figure 7-1.

d. Adjust R-104 for zero volts (±1 millivolt).

7.3.2 Gain Accuracy

a. Insert the one millivolt full scale gain module (11-4601-01) into the slot located in the front of the preamplifier.

b. Connect the differential voltmeter to the preamplifier output terminals (positive lead to pin D terminal and negative lead to pin G terminal).

c. Connect the calibrated voltage source to the preamplifier input (positive lead to HI terminal and negative lead to LO terminal). Set calibration voltage to 0.000 (differential voltmeter should read zero volts).

d. Apply full scale voltages to the preamplifier input as follows:

INPUT VOLTAGE	PLUG-IN GAIN MODULE	FULL-SCALE OUTPUT VOLTAGE
0.001 ± .02%	11-4601-01	1 volt ± .25%
.01 ± .02%	11-4601-04	1 volt ± .25%
.1 ± .02%	11-4601-07	1 volt ± .25%
1. ± .02%	11-4601-10	1 volt ± .25%
10. ± .02%	11-4601-13	1 volt ± .25%
100. ± .02%	11-4601-16	1 volt ± .25%

e. Direct current voltage offset shift (from range to range) should not exceed ±2.5mv.

f. Removing gain module does not cause preamplifier to become unstable or the output to drift off scale.

7.3.3 Response Check

a. Connect square wave generator to preamplifier input. Set peak-to-peak amplitude of the input square wave to the full scale gain span voltage.

b. Connect oscillograph to the preamplifier output. Display square wave so that the rise time is easily read by using a high chart speed. (A convenient chart speed is 100mm/sec for short bursts, 10 msec/mm.)

c. Measure the rise time of the preamplifier with the following gain modules:

MODEL NUMBER	DESCRIPTION
11-4601-14	20V
11-4601-08	2V
11-4601-05	0.2V

(Rise time should be no greater than 0.1 second, measured from 1% to 99% of full scale, 50 divisions).

7.3.4 Maximum Safe Input

a. Insert 100 mv gain module (11-4601-07) into the preamplifier. Apply +15 vdc to the preamplifier input terminals.

b. Measure the dc voltage across diodes CR101 and CR102 (see Figures 7-1 and 8-17). The voltage must not exceed 8.8 vdc.

c. Apply -15 vdc to the preamplifier input terminals. Repeat step 2.

d. Repeat steps 1 and 2 using 220 vdc input.

NOTE: The two 5K, 4 watt resistors located on the gain module and main preamplifier card (see Figure 7-1) become hot if the voltage remains on.

7.3.5 Common Mode Rejection

a. Connect a 1000 ohm resistor between the HIGH and LOW inputs to the preamplifier.

b. Insert a 1 MV FULL SCALE gain module (11-4601-01) into the preamplifier.

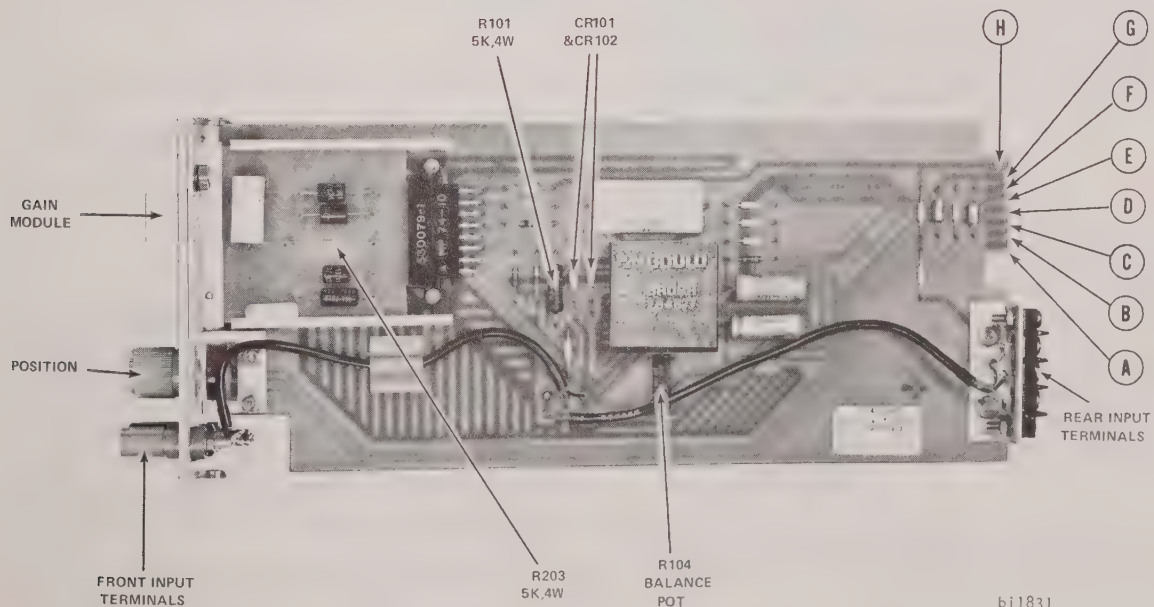


FIGURE 7-1 FIXED SPAN PREAMPLIFIER (13-4715-07)

c. Connect preamplifier output to oscillograph. Set sens/div to 0.001 volt.

d. Apply a 10 volt peak-to-peak (60Hz) sine wave to the preamplifiers LOW and GD input, with respect to the preamplifier housing. Secure front panel to preamplifier housing with a screw. Connect printed circuit connector terminal "H" to the preamplifier housing (see Figure 7-1).

NOTE: Use the ac line voltage into a variac connected to an isolation transformer as the common mode drive voltage source.

e. The output peak-to-peak voltage should not exceed 0.010 volts peak-to-peak or 10 divisions of the oscillograph when it is set to 1 mv/div sensitivity.

7.3.6 Noise Check

a. Insert a 1MV FULL SCALE gain module (11-4601-01) into the preamplifier. Short the three input terminals (HI, LO, and GD) together.

b. Insert preamplifier into recorder mainframe. Operate strip chart recorder at 8 in/min and position the trace between two grid lines.

c. Noise should be one division (peak-to-peak) or less, on a single channel recorder (15-4318-xx).

7.4 MULTI SPAN PREAMPLIFIER (13-4715-06)

7.4.1 System Calibration

NOTE: When the Multi Span Preamplifier is installed in a Gould 110 Recorder perform the following:

a. Set POWER and CHART switches on.
b. Set CHART SPEED at 60 inches per hour.
c. Set SPAN knob to OFF.
d. Set OFFSET switch to OFF.
e. Set RESPONSE dial to FULL.
f. Adjust pen position potentiometer R220, located on the drive amplifier board 886046 (Figure 7-3) until the pen is on the zero grid line.
g. Allow preamplifier to warm up 30 minutes.

7.4.2 Chopper Amplifier Balance

a. Short the three input terminals (HI, LO, and GD) to the preamplifier together.

b. Set RESPONSE knob to .5 SEC position.

c. Set inner RESPONSE knob to MV (millivolts).

d. Connect a differential voltmeter to the output of the preamplifier (positive lead to pin D and negative lead to pin G). See Figure 7-2.

e. Rotate SPAN knob clockwise to .1 position.

f. Rotate variable SPAN control counterclockwise until it clicks.

g. Adjust the chopper amplifier course balance (R108) to approximately +1 volt output on the differential voltmeter.

h. Rotate fine balance adjust (R107) counterclockwise until the differential voltmeter voltage stops decreasing. Record the voltage. Rotate R107 clockwise until the voltage stops increasing and record the voltage. Add the lower reading to the higher reading, and divide the result by 2. Rotate R107 counterclockwise until the differential voltmeter indicates this number. The balance potentiometer is now in the center of its range.

j. Rotate chopper amplifier course balance (R108) until the output is less than 100 millivolts. Rotate the variable gain control from maximum counterclockwise to maximum clockwise and adjust R108 for less than 10 millivolts change. (1 division on strip chart.)

7.4.3 Offset Potentiometer

a. Connect a differential voltmeter to the output of the preamplifier (pins D and G). See Figure 7-2.

b. Rotate SPAN control to 10 and volts/millivolts knob to VOLTS. Set OFFSET toggle switch to OFF position. Set RESPONSE to FULL position. Rotate variable SPAN full counterclockwise until it clicks.

c. Connect calibrated voltage source to the input terminals of the preamplifier (plus lead to HI,

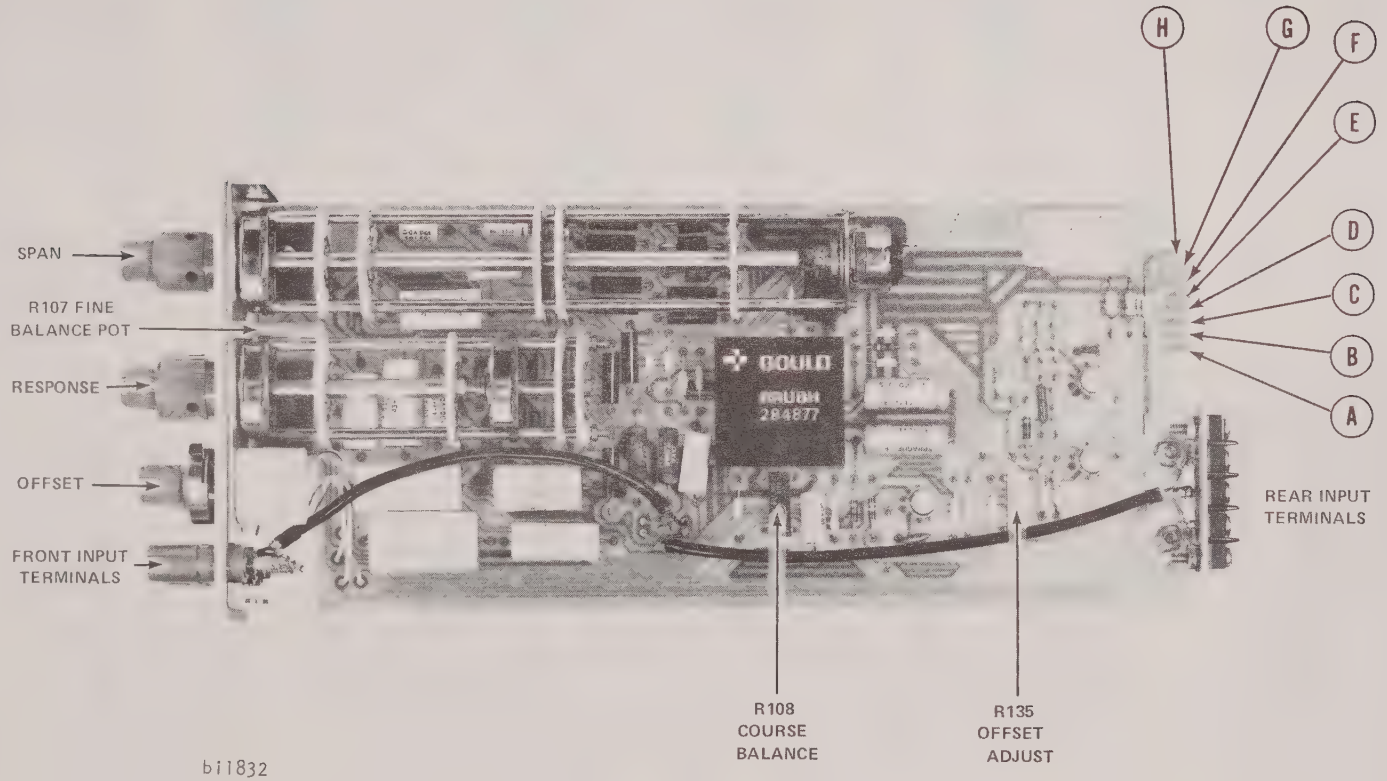


FIGURE 7-2 HIGH GAIN MULTI SPAN PREAMPLIFIER (13-4715-06)

negative lead to LOW). Set the voltage source output dials to 0.000. Record offset as read on voltmeter.

d. Apply 100 volts dc (+0.01%) to preamplifier input. Set the OFFSET polarity switch to "+". Set OFFSET vernier dial to 10.0.

e. Adjust potentiometer R135 to within ±2mv of reading in 7.4.3c, above.

7.4.4 Response Check

a. Connect a square wave generator to the preamplifier input.

b. Set peak-to-peak amplitude of input square wave to SPAN dial settings e.g., 10 volt peak-to-peak square wave for 10 volt full scale span, etc.

c. Connect preamplifier output to an oscillograph.

d. Set square wave generator to 1Hz. Set RESPONSE knob to FULL position. Set OFFSET toggle switch to the OFF position. Set variable SPAN control to X1. (Turn full counterclockwise until gain control clicks.)

e. Adjust the square wave amplitude to get full scale deflection on the oscillograph (1 volt peak-to-peak). A convenient chart speed is 100 mm/sec for short bursts (1 mm of chart equals 10 milliseconds).

f. Rise time in the full response setting should be less than 50 milliseconds.

g. Lower the square wave frequency to 0.25Hz.

h. Measure rise time in the .5, 1, and 2 second RESPONSE mode settings. Measured rise time should be within ±20% of indicated settings.

7.4.5 Noise Check

a. Short the input terminals to the preamplifier (connect HI, LO, and GD together).

b. Set RESPONSE switch to FULL.

c. Set VOLTS/MV switch (concentric with the RESPONSE switch) to MV.

d. Set SPAN switch to .1.

e. Set OFFSET toggle switch polarity to "–".

f. Insert preamplifier into the strip chart mainframe and set CHART SPEED at "8 in/min".

g. Adjust OFFSET vernier to position the pen trace between two grid lines.

h. Noise should be one division (.010V) or less (peak-to-peak).

7.4.6 Balance Check

a. POWER and CHART switches on.

b. RESPONSE in 1 sec. position.

c. CHART SPEED in 60 inches/hour position.

d. Turn SPAN switch maximum clockwise.

e. Volts-millivolts switch to mv position.

f. Rotate variable SPAN knob from maximum counterclockwise (detent position) to maximum clockwise end.

g. Pen can deflect a total of 2 divisions (minor divisions).

h. Switch volts-millivolts switch to VOLTS.

j. Pen can deflect a total of .3 divisions.

k. Adjust fine balance pot (hole in front panel) so that when step "f" above is performed there is less than 2 div of pen movement in VOLTS mode and in millivolts mode.

7.4.7 System Gain Check

a. POWER on.

b. CHART off.

c. Drive amp plugged into EXTENDER card.

d. Set Multi Span Preamplifier SPAN switch to OFF.

e. Connect calibrated voltage source to + & LO terminals of preamplifier.

f. Put RESPONSE switch in FULL.

g. Put OFFSET switch in OFF.

i. Switch CHART switch on and CHART SPEED to 1 inch/minute. SPAN switch to 1 volt.

j. Set voltage source bias to 0.000 and switch CHART switch on. Pen should be at the zero grid line within ±.1 division.

k. Switch calibrated voltage source to 1.0 volt ±.02%.

l. Pen should deflect 100 div ±.25 div.

m. Set source to .5 volts ±.02%.

n. Pen should deflect 50 div ±.25 div.

7.5 DRIVE AMPLIFIER (886048)

7.5.1 Preliminary Setup

a. Remove drive amplifier and insert extender board (886604).

b. Plug drive amplifier into the extender board.

c. Allow a thirty minute warm up period before preforming the following tests on the drive amplifier.

7.5.2 Reference Supply

a. Connect a differential voltmeter to the drive amplifier (negative lead to TP-2 and positive lead to TP-1). See Figure 7-3 for the location of test points.

b. CHART switch remains in the OFF position.

c. Adjust R-212 for −10.000 volts (±0.005 volt).

d. Reposition the negative lead of the voltmeter from TP-2 to TP-3.

e. Adjust R-215 for +6.000 volts (±0.003 volt).

f. Disconnect test leads.

7.5.3 Limiter Position and Scan Adjustment

a. Switch POWER and CHART controls to the ON position without the preamplifier plugged into the recorder.

b. Apply a dc voltage to the drive amplifier input (pin B) so that the writing pen is to the right electrical limit. See Figure 7-3. Adjust R-209 until the pen is on the right hand electric limit line (½ division to the left of chart edge).

c. Apply a dc voltage to the offset input (pin A) of the drive amplifier to position the pen to the center of the chart.

d. Apply a less than full scale 2.5-c sine wave to the drive amplifier input (pin B) and slowly increase the amplitude until the peaks of both the limiters and the signal is approximately 2% full scale.

e. Adjust R-209 until the trace is centered on the chart.

f. Adjust R-208 until the peaks of the trace are on the limit lines. A slight readjustment of R-209 and R-208 may be necessary to accurately position the trace on the limit lines.

7.5.4 Pen Position

a. Short the input terminals to the drive amplifier (see Figure 7-3).

b. Switch POWER and CHART controls to the ON position.

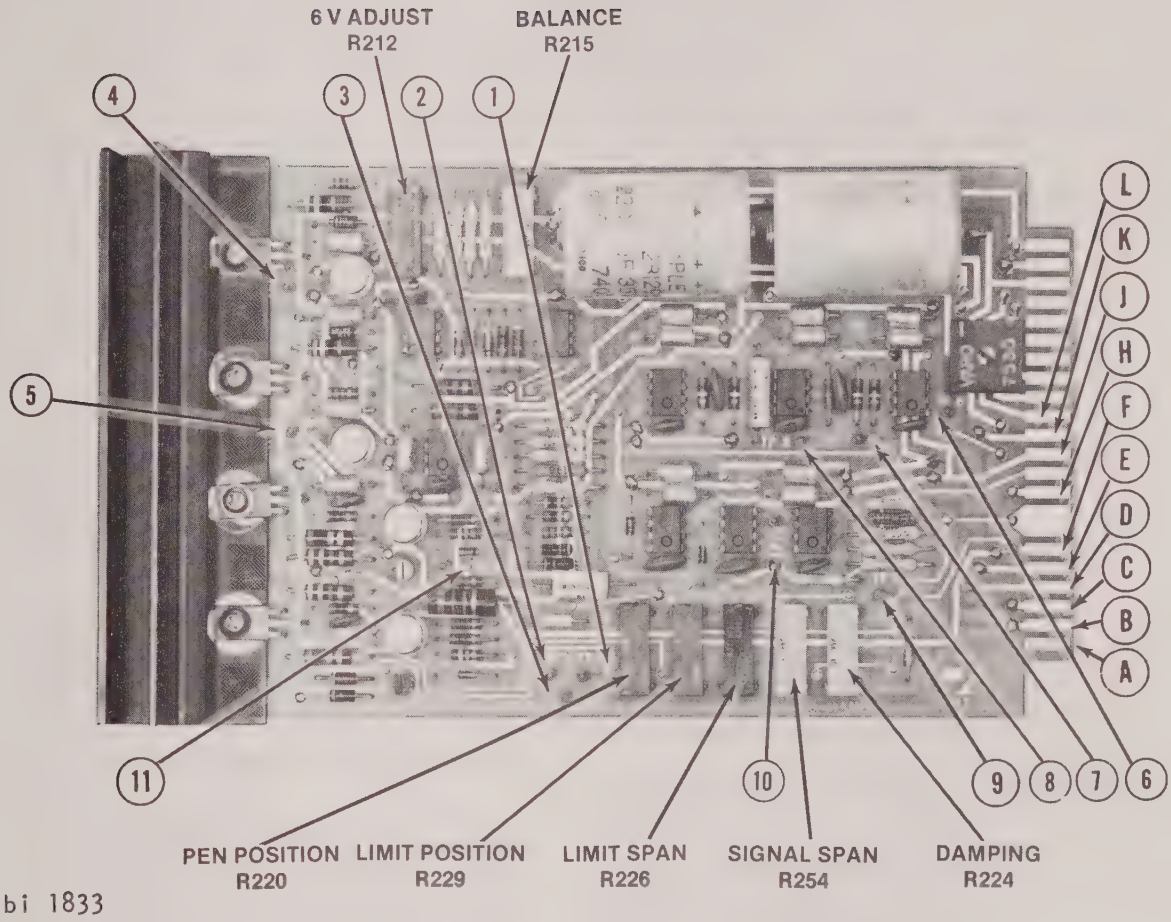
c. Adjust R220 (Figure 7-3) until the pen is on the zero grid line.

7.5.5 Scan

a. Position writing pen on the zero grid line by shorting the input (pin B) of the drive amplifier to ground and adjusting pen position potentiometer R220 (see Figure 7-3).

b. Apply a positive one volt (±0.02%) signal to the drive amplifier input.

c. Measure the amount of error on the chart and adjust R254 until 50% of the error is corrected.



TEST POINTS		PINS	
1	+6V.DC REF	A	PEN POSITION
2	-6V.DC REF	B	INPUT SIGNAL
3	COMMON	C	COMMON
4	+15 V.DC	D	-15V
5	-15V.DC	E	+15V
6	POSITION FEEDBACK	F	+6
7	BUFFERED POSITIVE FEEDBACK	H	-6
8	POSITIVE FEEDBACK	J	-6
9	VELOCITY (DAMPING)	K	+6
10	LIMITER	L	POSITIVE FEEDBACK
11	SUMMING AMPLIFIER OUTPUT		

FIGURE 7-3 DRIVE AMPLIFIER BOARD (886046)

d. Remove the calibrate signal or turn calibrator dials to 0.000 volts.

e. Short the input on the drive amplifier and readjust R220 until the pen is on the zero grid line.

f. Repeat steps 2 through 4 until the position of the pen is exactly on the zero and full scale grid lines when the shorted and full scale (1 volt) input signals are applied.

7.5.6 Damping

a. Set CHART SPEED knob to 2in/min.

b. Adjust function generator output to 0.5 Hz square wave.

c. Connect the signal from the generator to the input terminals of the drive amplifier. (If the preamplifier is a multi span 13-4715-06, switch RESPONSE to FULL).

d. Apply a dc voltage (approximately 0.5 volts) to the offset input (pin A) of the drive amplifier so that the writing pen is centered on the chart. See Figure 7-3.

e. Apply a full scale square wave to the drive amplifier.

f. Adjust R224 until the overshoot is eliminated.

NOTE: Line voltage will affect the calibration. Perform the adjustment at nominal line voltage.

7.5.7 End of Chart Sensor

a. Place a piece of cardboard over the mainframe to simulate the light shielding effect of the unit case on the sensor.

b. Rotate R101 (end of chart sensitivity adjust) full counterclockwise. See Figure 7-4.

c. Switch POWER and CHART controls to the ON position.

d. Adjust R101 slightly beyond the point where relay K101 energizes and the chart switch indicator lamp illuminates.

NOTE: When removing writing table, the chart switch indicator lamp is extinguished. It illuminates when writing table is inserted (providing the chart paper is flat against the drive roll). This condition indicates proper operation/adjustment of the end of chart sensor.

7.5.8 Pen Heat

a. Install writing table in mainframe. Depress CHART switch to STOP position.

b. Adjust R117 maximum counterclockwise.

c. Switch POWER control to ON position.

d. Connect low COMMON lead of true RMS meter to TP-4 (**WARNING – LINE VOLTAGE ON NEARBY PINS**) and the high PLUS lead to TP-5 of the main control board. See Figure 7-4.

e. Adjust front panel TRACE DENSITY controls for maximum clockwise rotation.

f. Adjust the Variac to 115 volts and switch CHART control to the ON position. Set CHART SPEED at 2in/min.

g. Adjust R117 for 5.00 volts (±0.05 vac RMS).

CAUTION: VOLTAGE IN EXCESS OF 5 VOLTS CAN CAUSE DAMAGE TO PENS.

h. Adjust TRACE DENSITY knob for a clear and distinct trace.

j. Disconnect test leads.

7.5.9 Chart Speed Check

a. Switch POWER control to the ON position.

b. Swtich CHART control to the START position.

c. Set CHART SPEED knob at 1 in/hr. (or 2.5 cm/hr. fro metric units).

d. Check proper operation by observing the sweep second hand of a watch. The pulse drive motor output can be felt by placing a finger on the small pulley. Belt pulses occur at a rate of 0.25 Hz, or one pulse every four seconds for standard (English) chart speeds. Metric (50Hz) chart speeds occur at 0.21Hz rate, or one pulse every 4.8 seconds.

e. Connect a timing generator to one analog channel. Set generator amplitude for a convenient counting period. Set generator output fre-

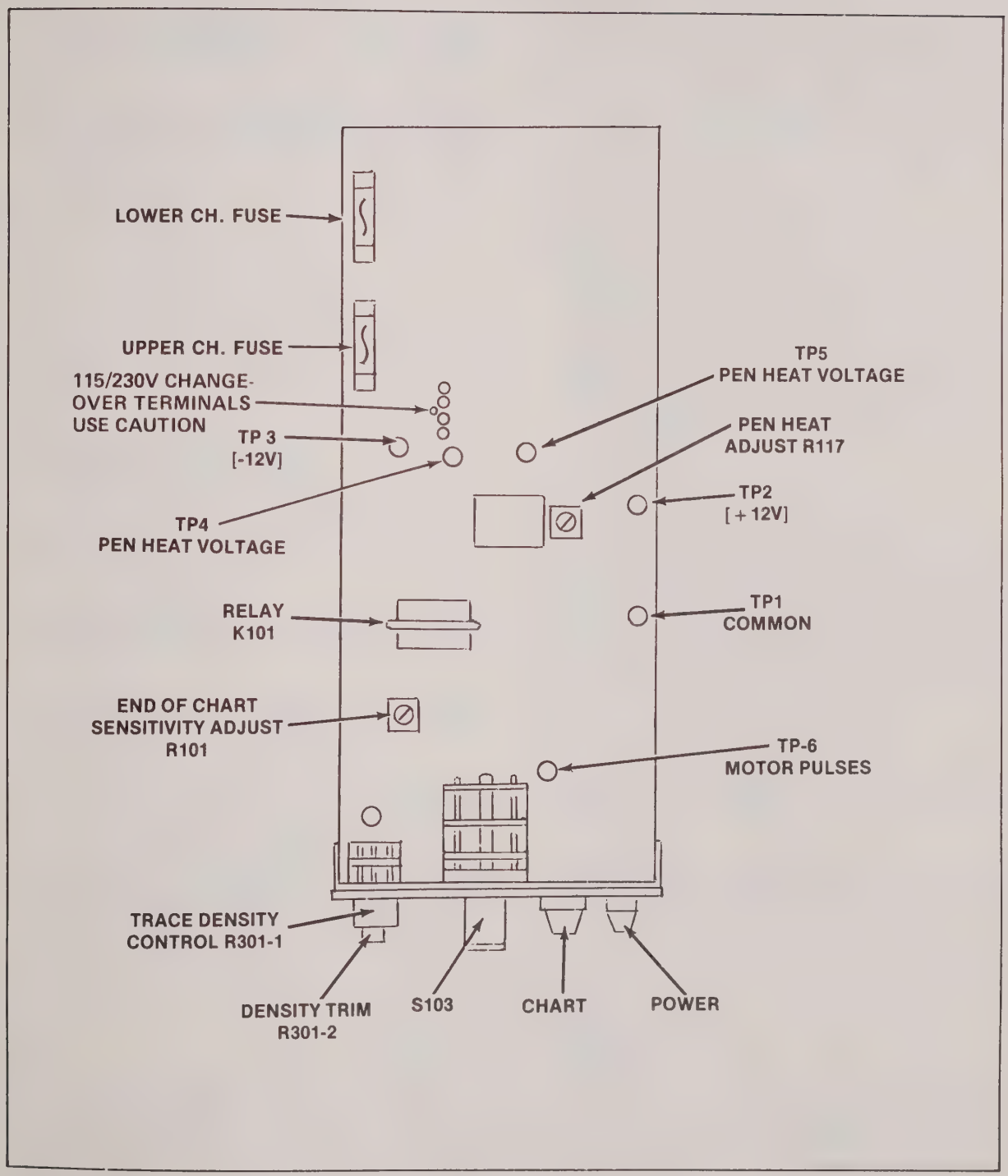


FIGURE 7-4 RECORDER CONTROL ASSEMBLY

quency to 0.1Hz (±.25%).

f. Set recorder CHART SPEED knob to 8 in/min. for standard (English) units. On metric units, set the CHART SPEED knob to 20 cm/min.

g. Count for six periods and measure the length of the chart. For standard chart speeds, the length is eight inches (±1%). Metric length is 20 cm, ±1%.

7.5.10 Writing Quality

a. Plug in a calibrated preamplifier.

b. Set CHART SPEED knob to 8 in/min.

c. Connect a signal generator to the preamplifier inputs.

d. Apply a 0.05 Hz triangle wave from the signal generator to the preamplifier.

e. Coordinate the preamplifier SPAN and OFFSET controls with the input signal for a full scale recording.

f. Adjust the DENSITY trim (inner, smaller knob of the TRACE DENSITY control) maximum clockwise.

g. Adjust the TRACE DENSITY control for a clear readable trace. Trace must be uniformly dense and distinct for 100 divisions.

h. Adjust the DENSITY trim knob counterclockwise, the lower pen trace density should decrease. In dual channel units this control is used to lower the density of the lower pen trace, thereby increasing the readability and eliminating confusion as to which trace is the lower channel.

7.5.11 External Pulse Drive Test

a. Connect a square wave generator to the PULSE INPUT on the rear panel of the recorder.

b. Apply a square wave signal to the recorder (greater than 2 and less than 30 volts, peak-to-peak). Adjust frequency to 120Hz (±1Hz).

c. Set CHART SPEED knob on the recorder front panel to R (maximum clockwise).

d. Place POWER and CHART switches to the ON position. The chart speed is now controlled by the frequency of the generator. The 120Hz input is the maximum frequency and provides the fastest chart speed of 8 in/min (or 20 cm/min for metric units). Chart speed is linear with respect to external input pulse frequency (i.e., 120Hz yields 8in/min; 60Hz yields 4 in/min,etc.).

7.6 LIMIT SWITCH (Figure 7-5)

The limit switch set point controller is a factory installed option available in either a single or dual channel recorder. Each channel control provides two independent switch set points at any desired position on the chart. Each set point is provided with a visual indicator located behind the writing table. To set a limit switch, perform the following:

a. Remove writing table.

b. Set channel to upper and lower limits desired using the OFFSET control located on the preamplifier.

c. Adjust limit control switches until lamp is illuminated for required limit settings for each channel.

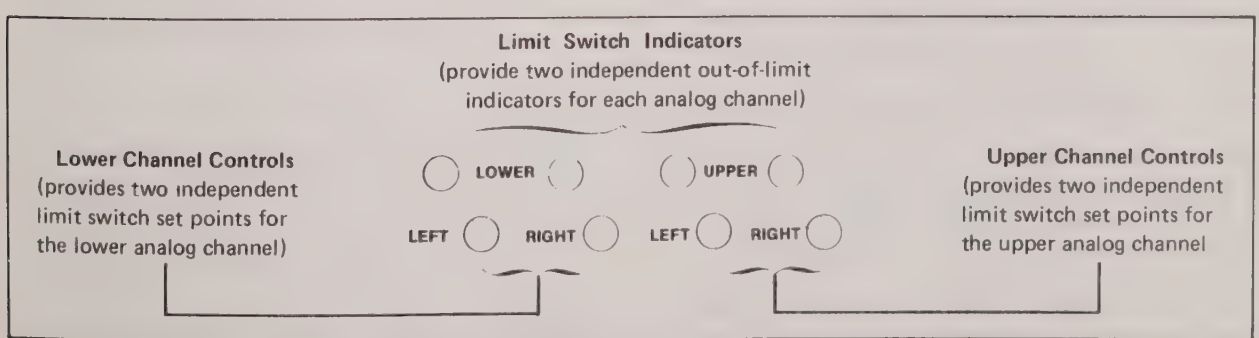

Limit Switch Indicators
(provide two independent out-of-limit indicators for each analog channel)
Lower Channel Controls
(provides two independent limit switch set points for the lower analog channel)
LOWER
UPPER
LEFT
RIGHT
LEFT
RIGHT
Upper Channel Controls
(provides two independent limit switch set points for the upper analog channel

FIGURE 7-5 LIMIT SWITCH INDICATORS

7.7 CHART INTEGRATOR (11-6105-00,-01)

NOTE: Integrator calibration should be performed only after the drive amplifier has been calibrated. (See Paragraph 7.5)

7.7.1 Initial Set-Up

a. Remove integrator P.C. board from mainframe card guide.

b. Disconnect harness wire which goes to pin 14 of integrator P.C. board. (Use extraction tool on molex contact).

c. Connect pin 14 on P.C. card to the HI terminal of the voltage source. Connect the LO terminal to TP-1 of integrator P.C. board.

d. Plug 15 pin molex connector into molex strip on P.C. card. Refer to Figure 7-6 for test points and adjustment pot locations.

e. Connect + lead of vom to TP-9 and - lead to TP-1. Set F.S. sensitivity to 10V. DC.

f. Turn POWER ON.

g. Integrator pen will move to the center of its travel.

h. Turn CHART switch ON. Pen may move to either side of chart or may sweep back and forth.

j. Adjust R151 for lowest pen drift when the voltage at TP-9 is 4.5 volts (Approx).

k. Now apply 100MV for as much time as it takes to cause voltage at TP-9 to go to +.7V.

l. Adjust R112 for minimum pen drift.

7.7.2 Polarity Sense Offset Adjust (R155)

a. Locate R155 on Figure 7-6.

b. Set FULL SCALE of VOM to read approximately 12V. and connect + lead to TP-5 and - lead to TP-1.

c. Turn on POWER on mainframe.

NOTE: Strip chart mainframe should be warmed up 30 minutes before any final adjustments or checks are made. Properly adjusted preamps must be used with integrator.

d. Set signal source voltage to +100 millivolts.

e. Reverse signal source polarity.

f. TP-5 voltage should switch to opposite polarity. If it does not switch, adjust R155 until it just switches.

g. Set source voltage to 10 millivolts and reverse polarity.

h. If the voltage at TP-5 does not switch to the opposite polarity, adjust R155 until it does.

j. Repeat steps d, e, & f, above, but reduce the signal until 0.5 millivolt is reached and TP-5 is switching polarity from approximately 11 volts to -11 VDC.

NOTE: Oscillation of TP-5 voltage with critical low input voltages is possible and permitted.

7.7.3 Full Scale Time Adjustment

a. Chart switch in OFF, power switch ON. Pen will be in center of its travel with chart switch in OFF.

b. Connect electronic counter hot lead to TP-2 and the common lead to TP-1.

c. Set START & STOP dials to 1.0 volts.

d. Switch input mode switch of counter to common so the same signal is used in starting and stopping clock.

e. Set START slope to negative and STOP slope to positive.

f. Set time base so that 1000 milliseconds can be read to the nearest 0.1 milliseconds.

g. Set voltage standard to +1.000 ±.01%.

h. The electronic counter gate light will flash OFF and ON. The gate light must be ON when the voltage at TP-9 is at approximately -4.5 volts. (Q101 is OFF).

j. Adjust R-106 for 1000 milliseconds ±.5 ms.

k. Now set START slop to (+) and STOP slope to (–). The electronic counter gate light will now flash ON when the TP-9 voltage is at +.7V, (Approx), indicating Q101 is ON.

l. Adjust R-109 for 1000 milliseconds ±.5 millisecond. The upscale time and down scale time have now been preliminarilly adjusted.

m. Switch voltage source to 0.000 volts.

7.7.4 Balance Adjust (Upscale & Down Scale)

a. Turn chart switch ON.

b. With voltage source apply 100 millivolts to input until TP-9 voltage is at -4.5V.

c. Adjust R151, balance adjust on Sub-panel for less than 2 counts/min. drift.

d. Jog pen to opposite alternation so that the TP-9 voltage is at +.7V approximately.

e. Adjust R112 balance adj. on P.C. board so that there is less than 2 counts per minute drift.

NOTE: A Gould 2000 series or equivalent will speed up this balancing process. Connect recorder across TP1 COMMON and TP-10. The initial sensitivity/div. is 500Mv. Increase sensitivity in order to SEE the drift and correct it W/O waiting for trend. Turn chart switch off.

f. Repeat Section 7.7.3, F.S. time adjustment, paragraphs g, h, j, k and l; touching up the FULL SCALE time pots.

NOTE: The balance and FULL SCALE time adjustments are interactive. If balance is not at min. F.S. alternation time will be OFF.

g. Set voltage source to 0.000.

7.7.5 Pen Centering and Span Adjustment

a. Turn power ON. Chart switch OFF.

b. If the pen is not on the center line of the integrator grid loosen set screw with allen wrench and position it there. Tighten set screw.

c. Switch voltage source to +1 volt and adjust R134 until the trace is centered on integrator grid.

d. Adjust R-149 for full scale trace. See Figure 7-6 for location of pots.

e. Leave the leads on the integrator P.C. board input.

7.7.6 Damping Adjustment

a. Set voltage source to 4 volts ±1%.

b. Adjust R143 for full scale deflection.

c. Check this adjustment by alternately applying 100MV & 4 volts signal and adjusting the damping to get constant amplitude ±2%.

7.7.7 Final Balance Adjustment

a. Disconnect all equipment test leads.

b. Reconnect harness wire which goes to pin 14 of molex strip. This connects the preamp to the integrator circuit.

c. Install integrator P.C. board in mainframe.

d. Short preamp input terminals (lower channel preamp). If the preamp is a multispan preamp 13-4715-06 be sure offset switch is in OFF. If it is a fixed gain preamp 13-4715-07 make sure that a gain module is plugged into the preamp.

e. Adjust R151 balance control for less than 2 counts/min. R151 is located on subpanel behind writing table.

f. R151 can be reached W/O removing the writing table as long as the main frame is not in a case. If the unit is cased, remove writing table and push the pushbutton next to balance pot R151. Adjust balance pot so that the integrator count is 2 counts per minute or less.

7.7.8 Baseline Zero Check

a. Set CHART SPEED to 60 in/hr or 150 cm/hr.

b. Turn CHART switch ON.

c. Observe the total number of counts per minute (each minor division of the integrator chart is worth 10 counts).

d. The total number of counts per minute should be less than 2 counts/min.

7.7.9 Accuracy Check

a. Touch up integrator balance so that the drift rate is less than ±2 counts per minute with preamp input shorted. Suggestion: Use fixed gain preamp and 1 VFS gain module.

b. Turn CHART switch ON. Switch chart speed switch to 4 inches per minute or 10 CM per minute.

c. Apply +1 volt DC ±.2 millivolt to preamp input. Connect positive voltage source lead to red HI preamp input and negative source lead to black LO.

d. There should be 6000 counts ±15 in one minute of chart. One minute of chart is 4 inches when using english model and 10 CM for the metric unit. The total count consists of the total number of FULL SCALE pen (1 inch) traverse plus the total of the partial traverses.

The following table should prove helpful:

1 Full Scale of Int. Pen	=	1 inch traverse.
1 Traverse of Pen	=	100 counts.
1 Traverse of Pen	=	10 minor division.
1 Minor Division	=	10 counts.
6 Traverses or 10 Traverses	=	1 L.H. + PIP or 1 R.H. - PIP.

NOTE: The pips occur every 600 or 1000 counts and are an aid in reduction of the chart data to a number.

e. Now with the chart speed at 4"/min. apply -1 volt ±.2MV to preamp.

f. There should be a total count of 6000 counts ±15 counts in 4 inches of chart.

g. Now with chart speed at 4"/min. or 10CM/min apply -0.1 volt ±.2MV. to preamp.

h. There should be a total count of 600 ±30 counts in one minutes worth of chart.

j. Repeat step "C" with +0.1 volt ±0.2MV. There should be 600 ±30 counts displayed.

7.7.10 Mechanical-Electrical Centering Check

a. Set chart speed to 60"/hr.

b. Apply +1 volt to preamp input. Adjust pen heat for clear distinct trace.

c. Individual triangle waves shall be centered in the 1 inch wide integrator chart band.

d. The 600 COUNT or 1000 count pips shall be clearly visible.

e. The integrator pips shall be .1 division high, MIN.

f. The integrator pips shall be on the left hand side for positive going signals.

7.7.11 Overrange Check

a. Same as 7.7.10b except slowly increase positive D.C. voltage to 4 volts ±40MV.

b. The amplitude should be one FULL SCALE (1.0 inch) ±.2 div.

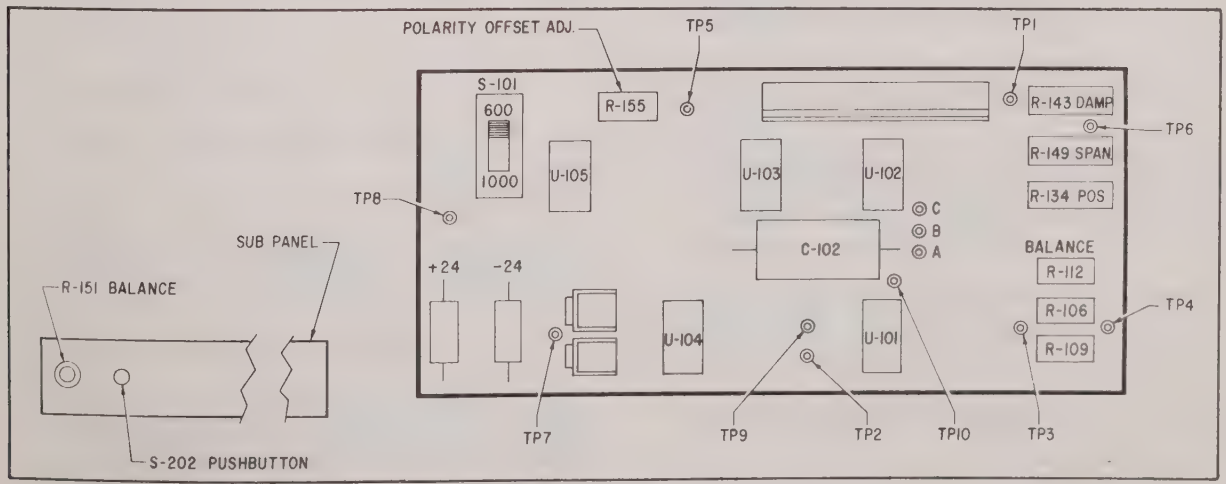


FIGURE 7-6 CHART INTEGRATOR

7.8 MEDIUM GAIN MULTI SPAN PREAMPLIFIER (13-4715-09)

NOTE: The MV-MVX10-VOLTS switch will be called "SPAN MULT." in the following procedure.

7.8.1 Calibration

7.8.1.1 Initial Setup

a. Set front panel controls as follows:

SPAN ..... 1 (maximum clockwise)
VARIABLE GAIN ... X1 (maximum counter-clockwise)
RESPONSE ..... FULL
SPAN MULT. ..... MV

b. Short input terminals.

c. Load output with 10K ohm.

d. Connect to + & – 15 vdc supply (may be obtained from recorder mainframe).

e. Measure voltage at TP-4 to TP-1. It should be +13.5 to +16.5 volts.

f. Measure voltage at TP-5 to TP-1. It should be -13.5 to -16.5 volts.

g. Connect scope "LO" to TP-1 and hi to TP-3 using 2 volt/cm vert. sensitivity. There should be no oscillations present. Move scope hi lead to amp output TP-6. There should be no oscillations present at output.

h. Let preamp warm up for 30 minutes inside of strip chart mainframe enclosure. (Test Fixture).

7.8.1.2 Internal Adjustments

a. Short input and put SPAN in OFF.

b. Connect D.V.M. to TP-6, preamp output.

c. Adjust R127 to get zero volts at TP-6 ±1mv. See Figure 7-7 for location of TP-6 and R127.

d. Switch SPAN MULT. sw. to MV.

e. Connect voltage calibrator to preamp input. Positive going voltage to HI preamp input terminal. Common of voltage source goes to LOW of preamp input.

f. Switch SPAN to 100.

g. Connect D.V.M. hi to TP-3 and DVM lo to TP-1.

h. Set voltage calibrator to 100 mv, ±50 microvolts (±.05%).

i. Record preamp output. Now switch SPAN MULT. sw. to VOLTS and apply 100 volts ±50 millivolts, (±.05%). Adjust R102, volts adj. to get the reading recorded above. This calibrates the input divider.

j. Leave lo term. of d.v.m. connected to TP-1. and remove voltage calibrator. Short preamp input.

k. Leave hi term of d.v.m. on TP-3.

m. Switch SPAN MULT. switch to MV.

n. Switch SPAN to 1 making sure var. gain control is in max. CCW position.

o. Adjust R112, offset balance, to get less than 10 millivolts at TP-3. (Preliminary offset balance adjustment.)

p. Set SPAN to 100 leave SPAN MULT. sw. in MV. Reconnect voltage calibrator to preamp input and set its output to aprox. 50 millivolts.

q. Turn R134 clockwise until output stops changing. Record this voltage at amp. output.

r. Turn R134 C.C.W. until output voltage stops changing. Record this voltage.

s. Subtract the lesser from the greater and divide by 2. Record this voltage value for use in step t.

t. Adjust R134, offset trim to get an amplifier output which is approximately equal to voltage recorded in step s. Now the offset trim pot is approx. in its electrical center.

u. Disconnect voltage calibrator and short amp input. Keep dvm. on TP-1 and TP-3.

v. Put span to 1 and SPAN MULT. sw. in MV. Var. gain pot max. CCW., X1 position.

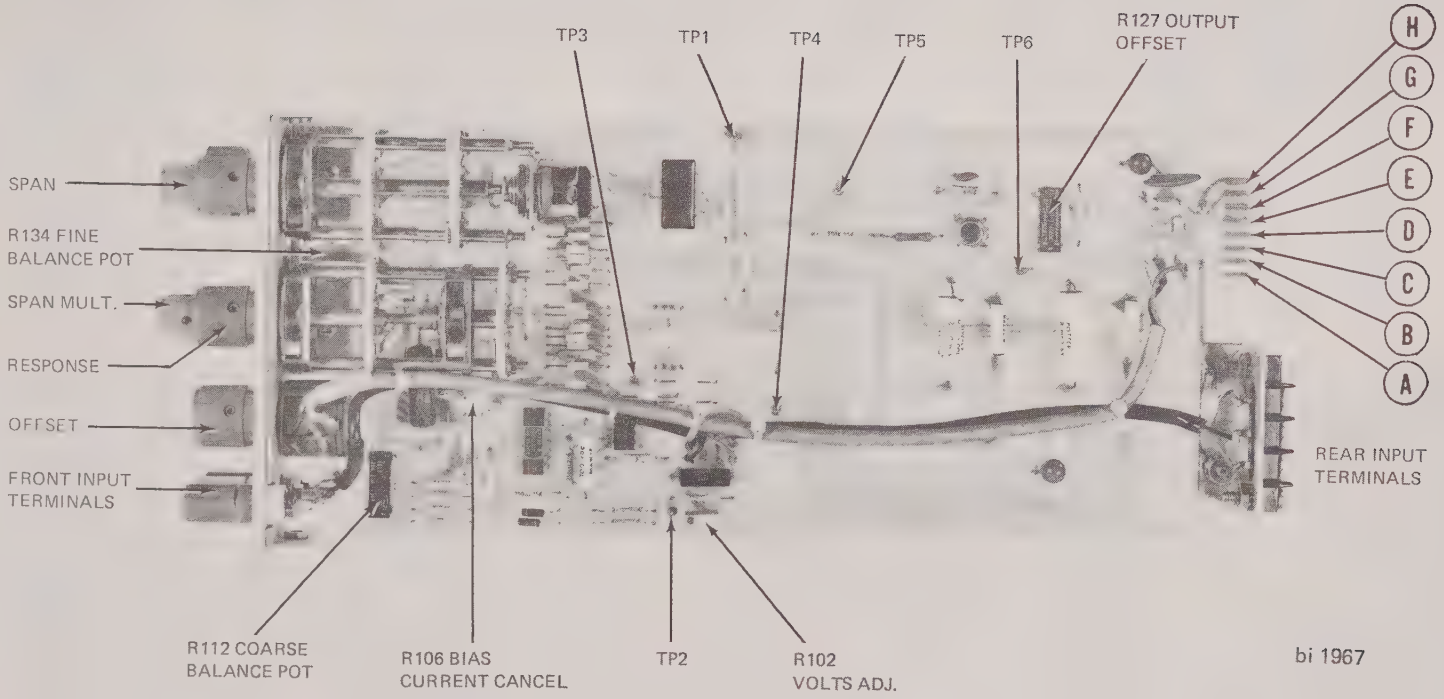


FIGURE 7-7 MEDIUM GAIN MULTI SPAN PREAMPLIFIER (13-4715-09)

w. Adjust R112 (see Figure 7-7) for less than ±0.020 volt at TP-3.

x. Now, adjust R134 for zero volts ±.001 volts. R134 is offset trim behind the front panel.

y. Remove short from preamp input and put a 10K ohm resistor across HI and LOW terminals and connect LOW and GD together.

z. Adjust R-106 so that there is less than 0.002 volt output change between 10K ohm across input and a shorted input.

7.8.1.3 Over Voltage Protection Test

a. Switch SPAN MULT to MV.

b. Switch SPAN to 1.

c. Apply 220 V DC or peak AC to HI and LOW amplifier input terminals.

d. There should be no damage to the preamp.

7.8.2 Inspection Procedure Gain Accuracy

a. Apply full scale voltages to all range. The output, measured at TP-6 on each range should be 1 volt ±.1% range to range and ±.2% on 1 mv & 2 mv full scale ranges.

SPAN MULT switch in MV

SPAN	VOLTS APPLIED	OUTPUT
100	100 mv. ± .01%	(Record actual output voltage.) 1 volt ± .25%*
50	50 mv. ± .01%	*
20	20 mv. ± .01%	*
10	10 mv. ± .01%	*
5	5 mv. ± .01%	*
2	2 mv. ± .01%	* + 2 mv.
1	1 mv. ± .01%	* + 2 mv.

* Total range to range output tracking error is 2MV. The max. output minus the min. output should be less than 2 millivolts on ranges 100 thru 5. Entire span range max. minus min. should be less than 4 millivolts. Entire span range is 100 volts thru 1 millivolt

SPAN MULT switch in MVX10

SPAN	VOLTS APPLIED	OUTPUT
1000mv or 1 volt	1000 mv ± .01%	*
500	500 mv ± .01%	*
200	200 mv ± .01%	*
100	100 mv ± .01%	*
50	50 mv ± .01%	*
20	20 mv ± .01%	*
10	10 mv ± .01%	*

* Total range to range output tracking error is 2MV. The max. output minus the min. output should be less than 2 millivolts on all ranges when SPAN MULT is in MVX10.

SPAN MULT switch in VOLTS position

SPAN	VOLTS APPLIED	OUTPUT
100	100 volts ± .01%	# *
50	50 volts ± .01%	*
20	20 volts ± .01%	*
10	10 volts ± .01%	*
5	5 volts ± .01%	*
2	2 volts ± .01%	*
1	1 volt ± .01%	

#The output at 100 volts should be within 200 microvolts of output value recorded in "100" millivolt span test.

*Total range to range output tracking error is 2 mv. The max. output minus the min. output should be less than 2 millivolts on ranges 100 thru 5. The maximum minus the minimum output should be less than 4 millivolts over the entire span range. The entire span range is 100 volts thru 1 millivolt.

b. X1-X3 (Variable gain Control) Check

Turn SPAN MULT switch to VOLTS. RESPONSE switch to .5 sec. position. Monitor output "TP-6" with D.V.M. Apply 1 volt ±1% to preamp input and read approx. 1 volt DC at amp. output. Turn (X1-X3) variable gain control from max. C.C.W. to max. C.W. position. The amp output should increase to at least 2.8 volts or more.

c. RESPONSE Check (Time Measured 1-99% of F.S.)

With RESPONSE switch in full and a 1V. p-p 0.25Hz square wave connected to preamp input, set SPAN to 1 volt full scale. Connect preamp output to oscillograph. Adjust PEN POSITION, VOLTS/DIV and var. gain control for centered, full scale square wave signal. Run chart at 100mm/sec. Measure rise & fall time of square wave. The rise & fall time measured 1-99% of full scale should not exceed 70 milliseconds. Switch RESPONSE to 0.5 SEC position. Measure response time. The response should be 500 milliseconds ±100 milliseconds.

d. OFFSET Control Check (Front Panel)

Apply -6 volts ±10% to the preamp card-edge connector terminal "A" (see Figure 7-7). Apply +6V. ±10% to terminal "B". Connect common of power source to preamp terminal G, or TP-1. Connect hi of D.V.M. to preamp edge connector F. Rotate offset pot max. CCW. Note: offset pot is ten turn. Read D.V.M. voltage. This CCW end voltage should be at least +4.9 volts. Now rotate offset pot C.W. observing the voltage decrease to zero and increase to a minimum of -4.9 volts.

e. Noise Check

Connect common, TP-1 to lo-common of Gould 2000 series recorder or equivalent. Short input to preamp. See SPAN at 1 millivolt F.S. RESPONSE switch at FULL. Connect preamp output, thru 1.6 mfd ±10% to hi input term of oscillograph having 1 megohm internal resistance. Now switch sens./div. dial on oscillograph to .5 mv/div. Operate chart at 1mm/sec. There should not be more than 2 div. of noise.

f. Common Mode Rejection

NOTE: For this test the preamp must be in the mainframe housing which is connected to ground.

a. Set SPAN to 1 and SPAN MULT to MV.

b. Connect preamp output to oscillograph (Gould 2000 series or equivalent.)

c. Switch RESPONSE to FULL.

d. Put a 1000 ohm resistor between HI and LOW terminals of amp. Connect LOW to GD.

e. Apply a 10 v. p-p 60HZ sinewave to LOW term and case of preamp housing which is at ground potential. (Preamp housing is test fixture).

f. Set sens./div. of oscillograph to 1mv.

g. Output should be 10 millivolts or less. Ten divisions or less on oscillograph. (Make sure that oscillograph response is flat out beyond 60HZ. at 10 divisions deflection.

7.8.3 System Inspection Procedure - Preamp Plus Stripchart Mainframe

7.8.3.1 Gain Accuracy

a. Plug preamp into a Gould 110 stripchart recorder mainframe and turn POWER sw. on. Let preamp warm up for 30 minutes with CHART switch set to STOP.

b. Turn CHART switch on & set CHART SPEED to 1 INCH PER MIN. or equiv. metric speed. Turn SPAN to OFF and RESPONSE to FULL. Adjust OFFSET pot from CCW end to CW end. Pen should move over entire chart and go into l.h. and r.h. signal limits. Position pen at r.h. chart grid line ±.1div.

c. Connect voltage calibrator to preamp input. Apply voltage to all ranges as listed in this calibration procedure. Deflection should be within limits as follows:

1. Spans 100V thru 5 mv FS ±.25% of fullscale deflection.

2. Spans 2 mv & 1 mv.F.S. ±.35% of fullscale deflection.

7.8.3.2 Linearity

a. Set SPAN to 1 and SPAN MULT switch to VOLTS. Switch RESPONSE to FULL and var. gain control to X1 (CCW end).

b. Turn CHART on. Set CHART SPEED to 1 in/min. Use OFFSET pot to position pen on r.h. chart grid line.

c. Connect voltage calibrator to preamp input and set to 1.000 volt ±.01% (±100 microvolts).

d. Pen should deflect 100 div. ±0.25 div.

e. Now step input voltage from 1 volt to 100mv. ±.01% in 100mv steps.

f. Pen should move by 1/10 f.s. steps ±.25 div./ 100mv change in signal input.

g. Repeat above linearity check with SPAN MULT. switched to "MVX10" and reduce voltage calibrator output to 100MV ±.01% (±10 micro volts). Pen should deflect 100 div. ±.25 div. Step input voltage from 100 m.v. to 10 m.v. ±.01% in 10 m.v. steps. Pen should move by 1/10 F.S. steps ±.25 div/10 m.v. change in signal input.

7.8.3.3 Noise Check

a. Short amp input terminals and set full scale SPAN at 1 millivolt.

b. Switch RESPONSE selector to FULL.

c. Run chart at 8"/min. or 100 cm/min. & examine noise amplitude.

d. Noise should not exceed 0.1 div. p-p.

NOTE: Trace width comparisons with event marker traces or analog traces will aid in evaluating p-p amplitude. Bear in mind that the amount of pen heat changes the line width. Two lines compared should have aprox. the same heat and pen pressure.

7.8.3.4 Zero Shift with Span

a. CHART on; 1 in/min. CHART SPEED.

b. SPAN MULT sw. in MV.

c. RESPONSE in FULL.

d. Shorted input terminals.

e. Rotate SPAN sw. C.W. max. and back to max. CCW, OFF.

f. Total zero shift should not exceed 0.2 div.

7.8.3.5 Isolation Test

a. Connect Ohmmeter between GD term and HI.

b. Resistance should be 100 megs or more.

c. Connect ohmmeter between GD and case.

d. Resistance should be 100 megs or more.

e. Connect LOW and GD together and measure resistance between LOW and case.

f. Resistance should be 100 megs or more.

SECTION VIII

PARTS IDENTIFICATION

8.1 GENERAL

The Gould 110 Strip Chart Recorder has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment avaiable, contact your nearest Gould Service Engineer listed on the warranty card shipped with the recorder.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order.

1. Name, model number, and serial number of the instrument.

2. Description of the parts as listed in the manual.

3. Gould part number.

NOTE: Do not use the symbol number from the parts list for identifying desired parts on the order.

The Parts Identification section is divided into subsections illustrating the mainframe, preamplifiers, and options/accessories.

The following parts lists, exploded views, and schematic diagrams, are designed to assist in servicing and repairing the recorder.

Recommended Spare Parts are indicated by the (†) symbol.

8.2 MAINFRAME (15-4318-00, 15-4328-00)

The "mainframe" subsection contains an illustrated parts breakdown of subassemblies comprising the 110 Strip Chart Recorder (including parts lists and schematic diagrams).

8.3 PREAMPLIFIERS

The Gould 110 Strip Chart Recorder is designed to accomodate various types of preamplifiers. See paragraph 1-4 for available models. The preamplifiers are in a group (following the mainframe section) which contains an exploded view of components for each preampifier, including parts lists and schematic diagrams.

8.4 OPTIONS/ACCESSORIES

The options/accessories are in a group following the preamplifiers. This group contains an illustrated parts breakdown, including a parts list and schematic diagram for each of the options available with the Gould 110 Strip Chart Recorder. The options and accessories illustrated are as follows:

- Limit Switch (Single and Dual Channel 11-6103-01, 02)
- Chart Integrator (Single and Dual Channel 11-6105-00, -01)
- Event Marker (Left and Right Margin 11-6222-16, -17) *
- Retransmitting Potentiometer (Single and Dual Channel)

* **NOTE: For parts information on the left and right margin event markers see Figures 2-7 and 2-8, respectively, in the installation section.**

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
RECORDER ASSEMBLY-SINGLE AND DUAL CHANNEL MODELS, 15-4318-00, 15-4328-00
FIGURE 8-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	884885-1	Table Assy } See Figure 8-5	
	884885-2	Table Assy (Metric) }	
*2	885287-1	Recorder Subassy (Single Channel) } See Fig. 8-2	
	885287-2	Recorder Subassy (Dual Channel) }	
†3	287162	Resistor, Variable	
4	265760-1	Contact, Elec.	
5	886139	Case Assy (See Fig. 8-7)	
†6	116198-10	Fuse (All 115 volt models)	F-301
	266924-7	Fuse (All 230 volt models)	
7	1-282930-2	Pulley-20T. (All 60 Hz models)	
	1-282930-3	Pulley-24T. (All 50 Hz models)	
†8	269945-22	Belt, Timing	
9	684933	Panel Assy - S.S.	
	686648	Panel Assy - S.S.(Metric)	
10	285652-2	Knob, Control	
†11	286012-1	Switch, Toggle	
12	685102	Bezel, Switch	
13	285653-2	Knob, Control	
14	285651-1	Knob, Control	
15	281502-1	Contact, Elec.	

*Item 2 is not procurable, but items listed in Figure 8-2 are procurable.

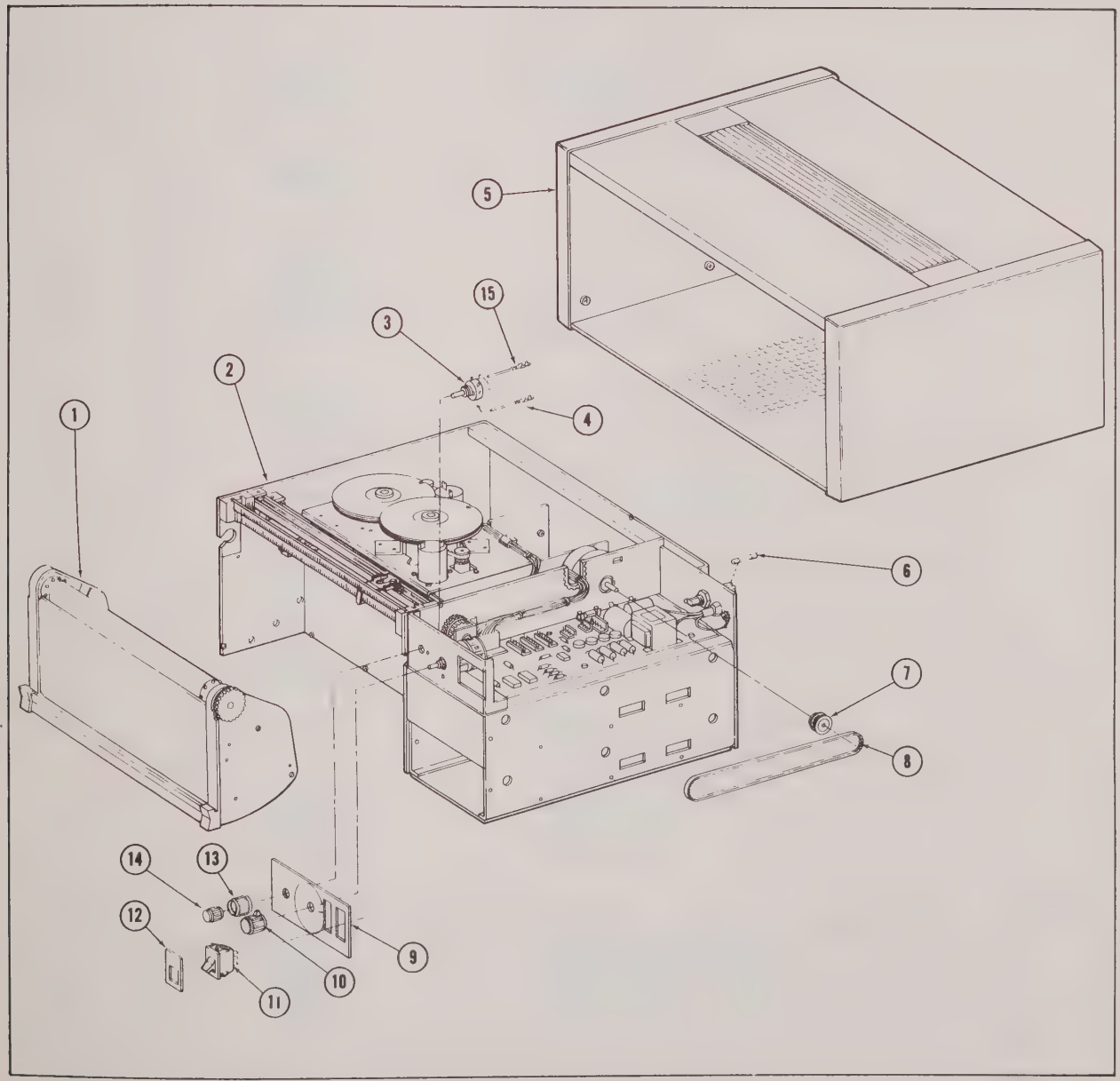


FIGURE 8-1 RECORDER ASSEMBLY (15-4318-00, 15-4328-00)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
** RECORDER SUBASSEMBLY – SINGLE AND DUAL CHANNEL MODELS, 885287-1, 885287-2
FIGURE 8-2

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	386471	Panel, Shield	
2	286320-1	Block, Clamping (Single Channel)	
3	286320-2	Block, Clamping (Dual Channel)	
* 4	885111-1	Chassis Assy (Single Channel) } See Fig. 8-3	
	885111-2	Chassis Assy (Dual Channel) }	
† 5	11-2824-37	Stylus Assy, Lower	
6	785942	Scale Assy. S.S.	
	686298	Track Assy, Upper (Includes items 7 through 9) (Dual Channel)	
7	686299	Track, Upper	
8	485926	Board, P.C.	
9	281502-1	Contact, Elec.	
10	686281-3	Bumper	
11	282923-2608	Screw, Self-Lock	
12	1-118195-303	Washer, Plain	
13	284812	Spring, Compression	
14	686292	Carriage Assy (See Fig. 8-3A)	
† 15	11-2824-36	Stylus Assy, Upper (Dual Channel)	
* 16	885112-1	Pen Drive Assy (Single Channel) } See Fig. 8-4	
	885112-2	Pen Drive Assy (Dual Channel) }	
17	786463-1	Panel, Rear (Single Channel)	
	786463-2	Panel, Rear (Dual Channel)	
18	886046-1	Board Assy, Drive Amp (See Fig. 8-10 & 8-11)	
19	286577-2	Cover	
20	286577-1	Cover	
21	129699	Jumper, Terminal Strip	
22	1-286155-4	Board, Terminal	TB-401
23	786465	Panel Assy, Rear Term Mtg.	
	786470	Harness Assy, Remote Chart (Includes items 24 through 27)	
24	232997-23	Strap, Retaining Cable	
25	265915-1	Contact, Elec.	
26	281502-1	Contact, Elec.	
27	9-281501-8	Connector	J-101-B
28	685451	Panel Assy, Blank (Single Channel)	
29	285167	Bracket (Single Channel)	
* 30	885088	Recorder Control Assy (See Fig. 8-6)	
31	287142	Cover (Single Channel)	

* Items 4, 16, and 30 are not procurable, but items listed in Figures 8-3, 8-4 and 8-6 are procurable.

** Recorder Subassembly 885287 not procurable. Use above listed items.

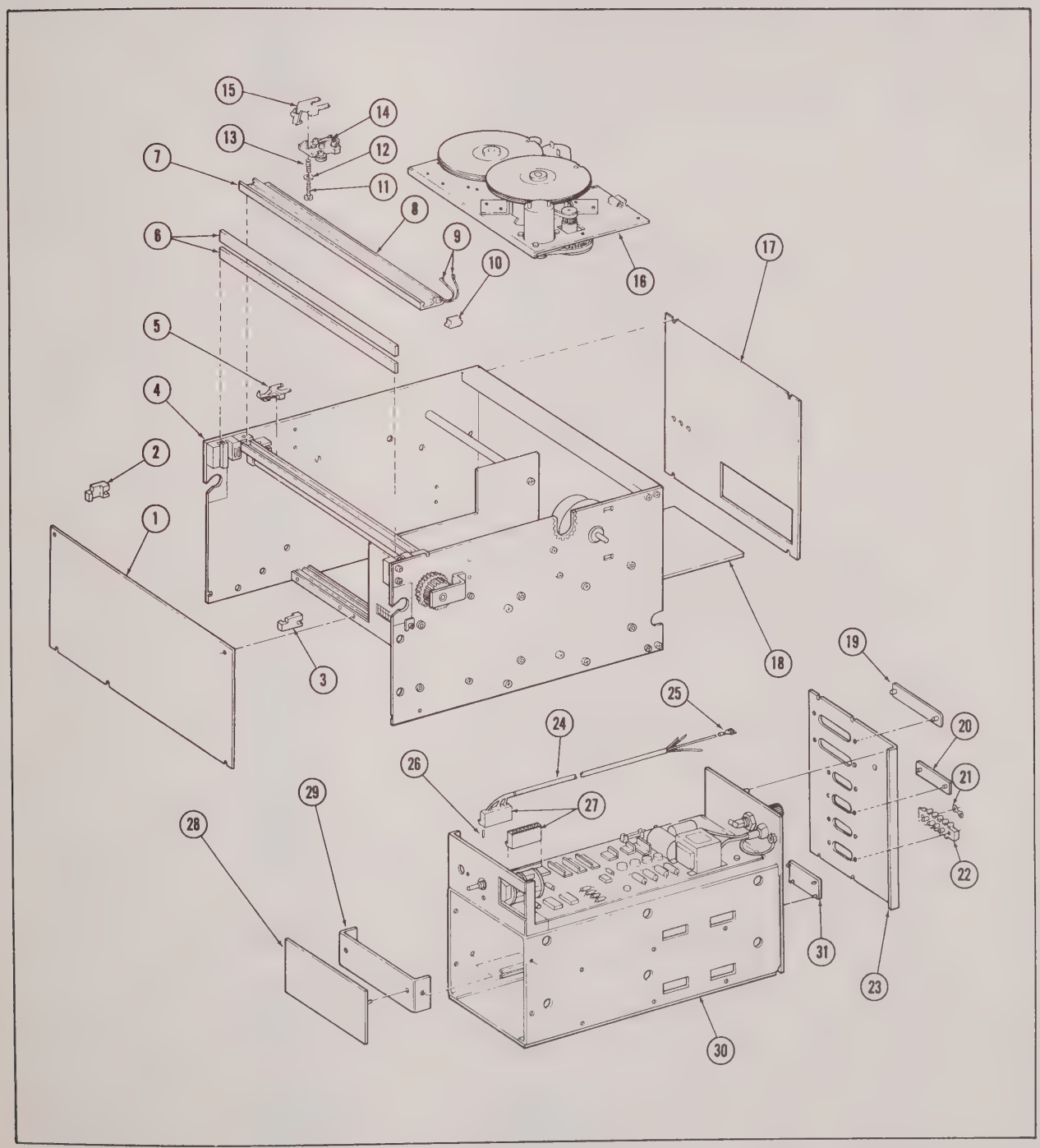


FIGURE 8-2 RECORDER SUBASSEMBLY (885287-1, -2)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
** CHASSIS ASSY-SINGLE AND DUAL CHANNEL MODELS, 885111-1, 885111-2
FIGURE 8-3

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	886321	Plate Assy, R.H. Side	
2	1-128693-3	Grommet, Cat	
	686766	Motor Assy, Stepping (Includes items 3 through 5)	
3	9-281501-8	Connector	J-107
4	281502	Contact	
†5	286004-1	Motor, Stepping	
6	282589	Bracket, Support	
7	240133-6	Bearing, Sleeve, Flanged	
8	682593	Pulley, Clutch Assy	
9	283864	Gear, 60 Teeth	
10	682590	Shaft, Modified	
11	270903-11	Clamp	
12	686285-1	Block Assy, R.H.	
	686285-2	Block Assy, R.H. (Dual Channel)	
13	282347-2	Spacer	
14	686278	Bar, Spacer, Top	
15	1-265849-4	Bracket, Mtg.	
16	686276	Bar, Spacer, Front	
17	886468	Harness Assy, Main (1 Req'd per channel)	
	283420-44	Connector, J201	
	286410-16	Connector, J202	
18	1-286156	Spring, Retaining	
19	232447-23	Strap, Retaining	
	686297	Track Assy, Lower (Includes items 20 through 25)	
20	285101	Clip	
†21	686289	Sensor Assy	
22	285103	Clip	
†23	485926	Board, P.C.	
24	281502-1	Contact, Elect.	
25	685925	Track, Lower	
26	686292	Carriage Assy (Includes items 27 through 34)	
*27	686295	Lug Assy	
28	31-119914-2603	Screw, Mach, Pan Hd. Slotted	
*29	686293	Carriage Subassy	
30	31-129647-40	Nut, Hex, Small Pattern	
31	1-216740-410	Lockwasher, Spring	
32	681632	Roller Assy	
33	227940-4	Ring, Retaining	
34	281630	Shaft, Eccentric, "Y" Carriage	

*Items 27 and 29 are not procurable separately, but only with item 26.
**Chassis Assy 885111 not procurable. Use above listed items.

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
CHASSIS ASSY - SINGLE AND DUAL CHANNEL MODELS, 885111-1, 885111-2
FIGURE 8-3

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
† 35	686252	Contact Assy	
36	885109-1	Chassis Assy	
	885109-2	Chassis Assy (Dual Channel)	
37	686281-1	Bumper	
38	686287-1	Block Assy, L.H.	
	686287-2	Block Assy, L.H. (Dual Channel)	
39	486322	Plate, Side L.H.	
40	686277	Bar, Spacer, Rear	
41	270903-12	Clamp	
	786486	Transformer Assy, Pwr.	
42	283408	Contact, Elect.	
† 43	285706	Transformer	
44	9-281501-4	Connector	
45	281502	Contact, Elec.	

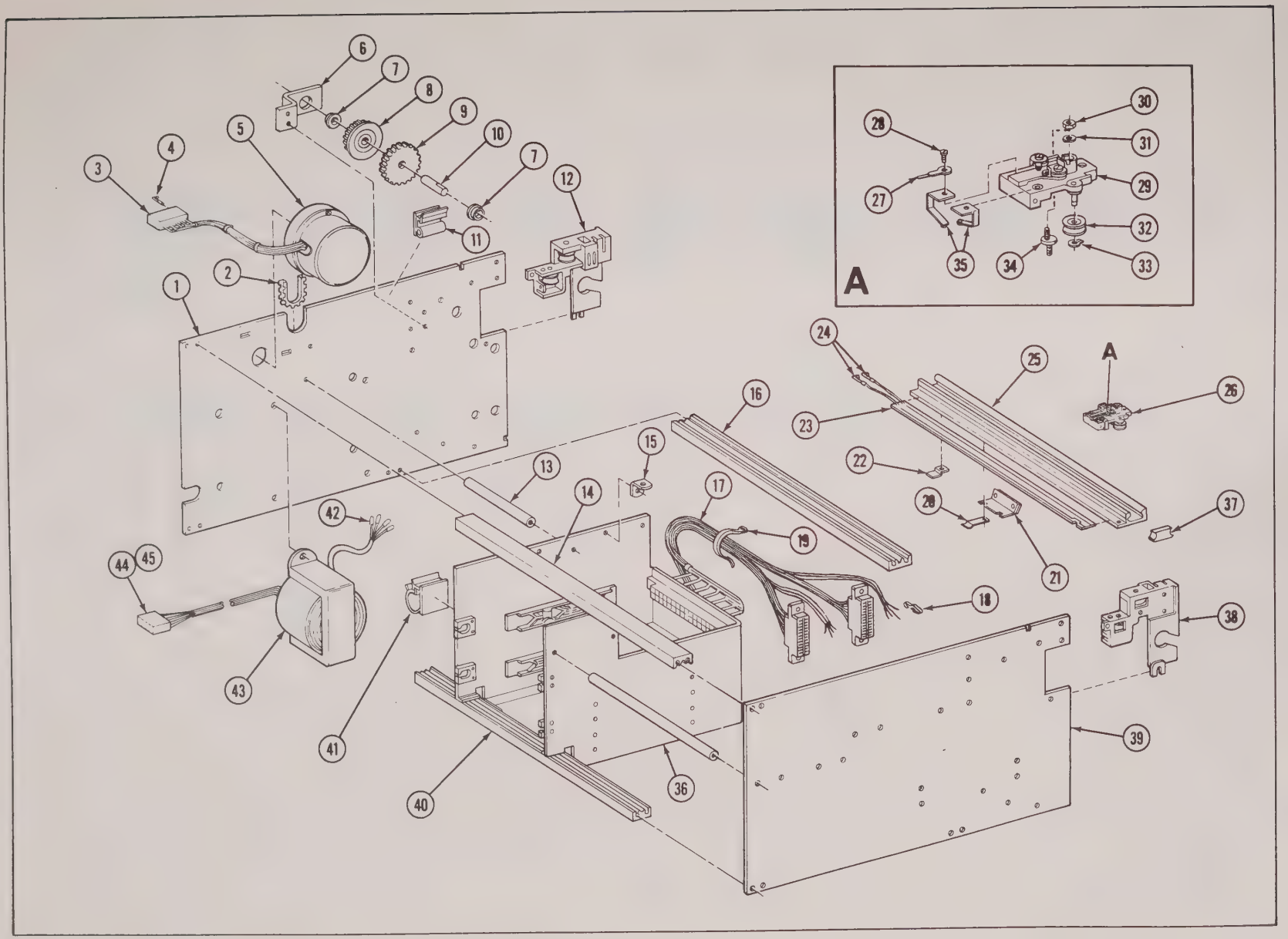


FIGURE 8-3 CHASSIS ASSY (885111-1, -2)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
*PEN DRIVE ASSEMBLY 885112-1 (Single Channel) & -2 (Dual Channel)
FIGURE 8-4

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	286473	Bracket	
2	386284	Chassis, Pen Drive	
3	286307	Adapter, Shaft	
4	31-121166-2602	Screw, Set	
†5	269945-23	Belt, Timing	
6	686305	Drum Assy	
	384520	Drum	
	285937	Flange	
	281585	Cable	
	31-119914-2604	Screw, Pan-Head (Slotted)	
	286306	Plate, Nut	
7	245203-4002	Screw, Set	
8	786308-1	Bracket Assy, Pot Mtg. (2nd Channel) (includes items 25-31)	
9	269945-23	Belt, Timing	
10	1-128693-3	Grommet, Cat.	
11	270903-11	Clamp	
12	1-269573-10	Spacer	
†13	786315	Motor Assy, Drive	
14	286209	Clamp	
†15	10-286148-103	Resistor, Variable	R-401
16	381373-3	Pulley-15 Teeth	
17	281511-1	Bearing, Ball-Flanged	
18	686311	Mount Assy, Motor	
19	269945-7	Belt, Timing	
20	286310	Shaft, Motor Drive	
21	381916-1	Pulley, 60 Teeth	
22	686312	Pulley Assy	
23	31-121166-2601	Screw, Set	
24	284431	Motor, D.C. (Maxon 2128.912-12.321-000)	
25	686305	Drum Assy	
	384520	Drum	
	285937	Flange	
	281585	Cable	
	31-119914-2604	Screw, Pan-Head (Slotted)	
	286306	Plate, Nut	
26	286307	Adapter, Shaft	
27	386309	Bracket, Pot Mtg.	
28	10-286148-103	Resistor, Variable (2nd Channel)	R-402-1
29	286209	Clamp	
30	245203-4002	Screw, Set Self Locking	
31	31-121166-2602	Screw, Set	

*Pen drive assy 885112 not procurable. Use above listed items.

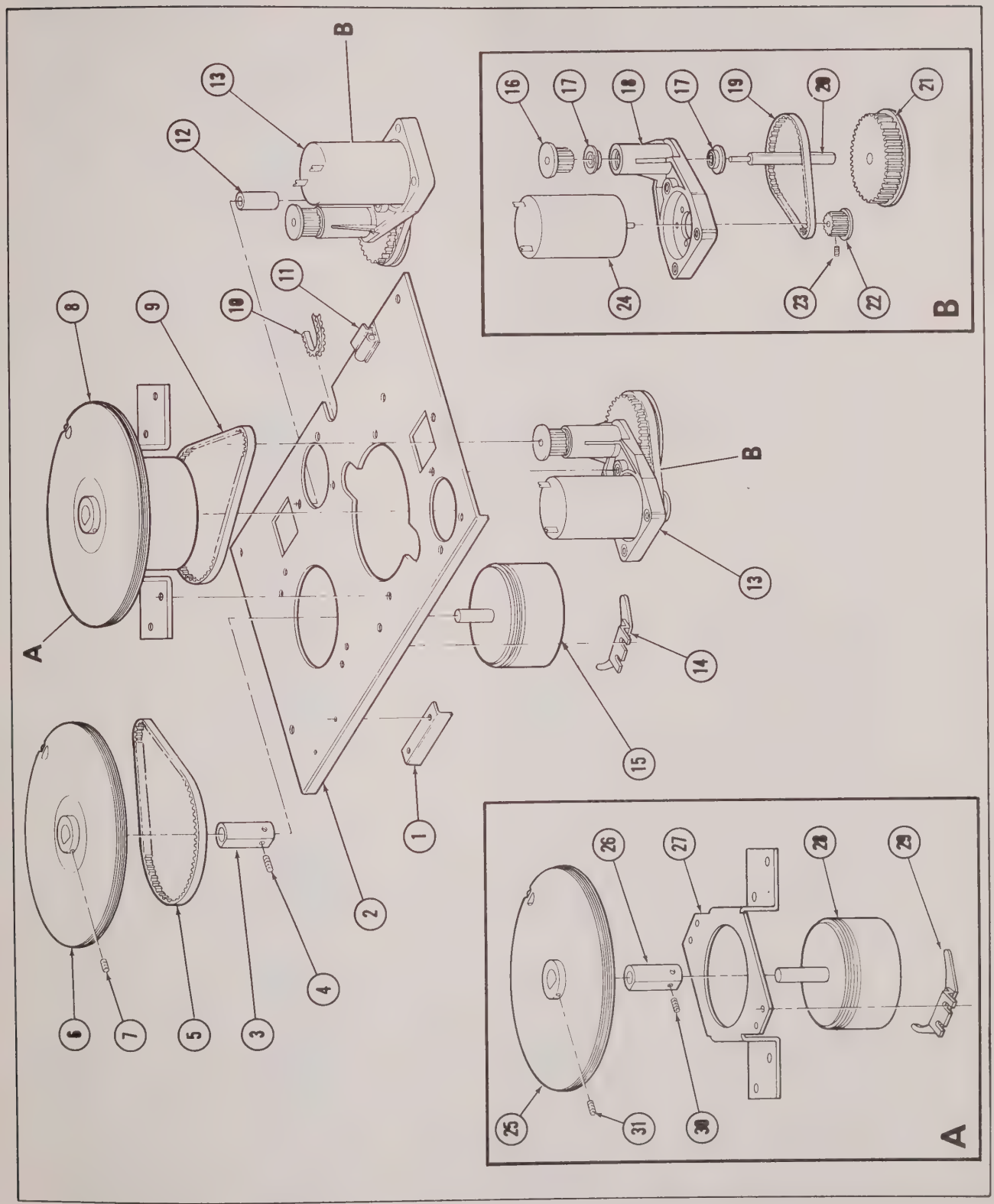


FIGURE 8-4 PEN DRIVE ASSEMBLY (885112)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
TABLE ASSY - 884885
FIGURE 8-5

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	684813-1	Bar, Pull	
†2	285997	Spring	
3	684846	Rod Assy, Idler	
4	684843	Roller Assy, Pressure (Includes item 5)	
†5	243867-11	"O" Ring	
6	784850	Plate Assy, L.H.	
7	384848	Table, Writing	
8	285200	Label, Paper Threading	
9	383798	Sprocket	
	385084	Sprocket (Metric)	
10	684842	Roller Assy, Drive	
	685174	Roller Assy, Drive (Metric)	
11	286279	Plate, Stiffener	
12	3-227070-2	Ring, Retaining	
13	284855	Roller, Idler Arm	
14	384165-4	Arm, Idler	
15	127271	Washer, Flat	
†16	269945-19	Belt, Timing	
17	284814	Shaft, Support	
18	384348-3	Hub, Supply Roll	
19	283864	Gear, 60 Teeth	
20	784849	Plate Assy, R.H.	
21	0-240731-2	Ring, Retaining	
22	684847	Hub Assy, Take-Up Roll (Includes items 23 through 28)	
23	284819	Bushing, Threaded	
24	384165-2	Pulley, 28 Teeth	
25	284851-1	Disc	
26	384348-1	Hub, Take-Up Roll	
27	265672-2	Washer, Flat	
28	13-127640-5	Washer, Special	
29	2-270124-2	Nut, Lock	
30	684844	Bushing Assy, Take-up (includes items 31 through 34)	
31	1-227070-9	Ring, Retaining	
32	384348-2	Bushing, Take-up	
33	243862	Spring, Comp.	
34	384348-5	Shaft, bushing	
35	684845	Bushing Assy, Supply Roll (includes items 31, 33, 34 and 36)	
36	384348-4	Bushing	
37	283549-1	Core, Paper Wound	

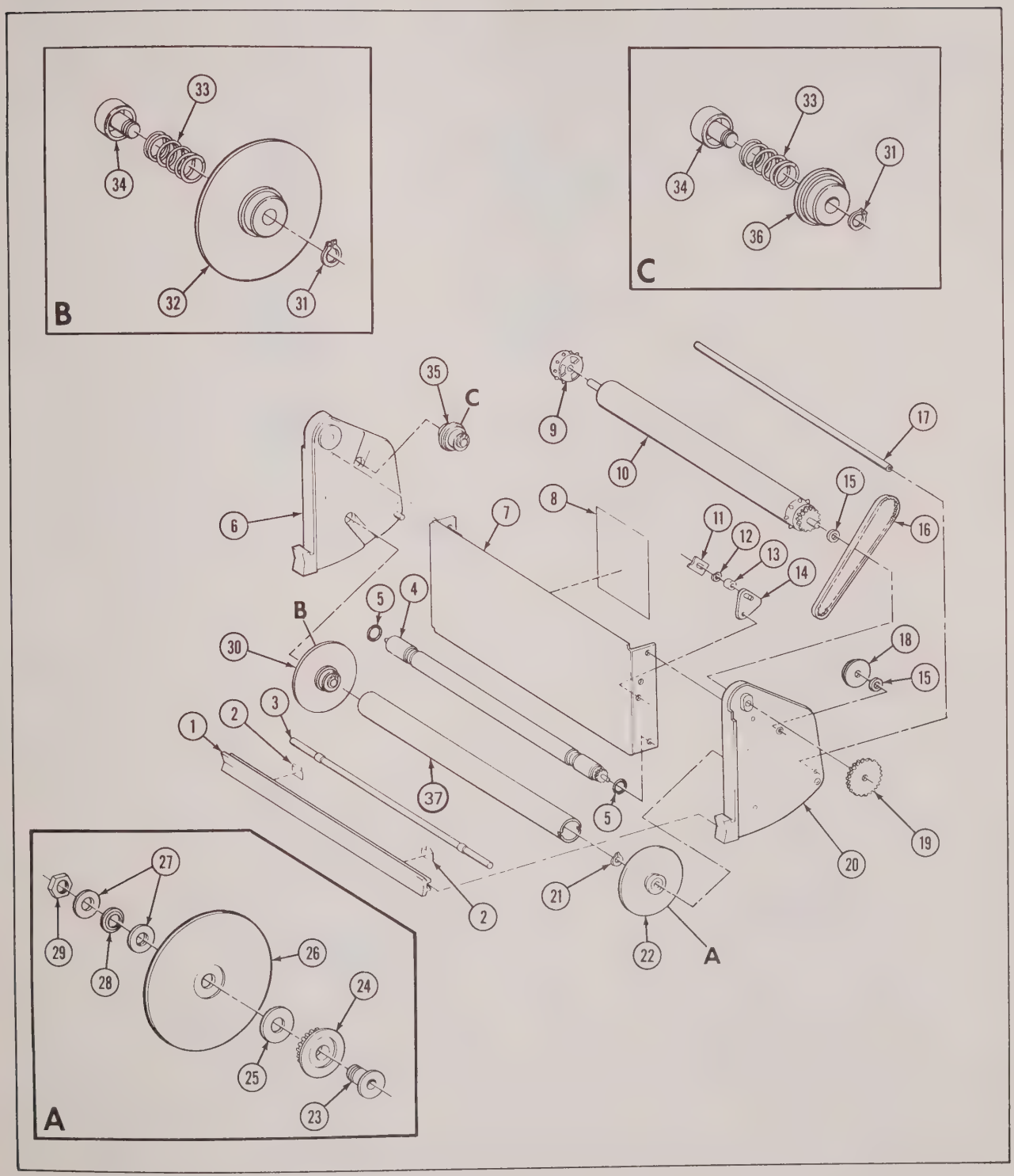


FIGURE 8-5 TABLE ASSEMBLY (884885)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
* RECORDER CONTROL ASSY - 885088
FIGURE 8-6

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	386039	Panel, Mtg	
2	886394	Board Assy (See Fig. 8-8 & 8-9)	
	786426	Harness Assy (Includes items 3 through 5)	
3	265760-1	Contact, Elec	
4	265840-2	Lug, Term	
5	270160-1	Lug, Term	
6	786041	Panel Subassy, Rear	
7	129758-1	Fuseholder	
8	108572-11	Strain Relief	
9	126295-7	Cord, Power	
10	241026-3	Lug, Term	
11	243898-62	Nut, Assembled Lockwasher	
12	486042	Chassis Subassy	

* Recorder Control Assy 885088 not procurable. Use above listed items.

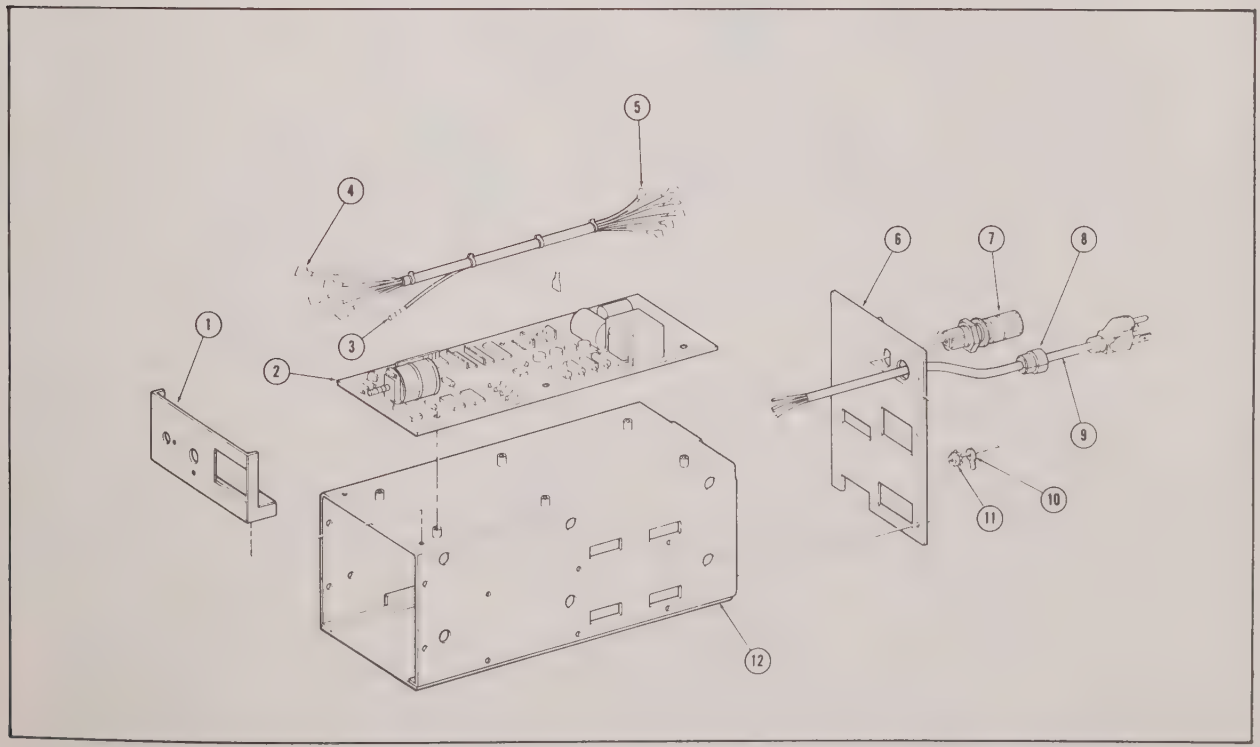


FIGURE 8-6 RECORDER CONTROL ASSY 885088

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
CASE ASSY - 886139
FIGURE 8-7

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	485558	Cover, Side	
	886182	Saddle Assy (Includes items 2 through 4)	
2	686096-1	Plate, Top	
3	686098	Plate, Handle Mtg.	
4	486140	Saddle	
5	686100	Plate Assy, Anchor	
6	286097	Strap, Handle	
7	685518-1	Handle	
8	2-270910-2	Bumper	

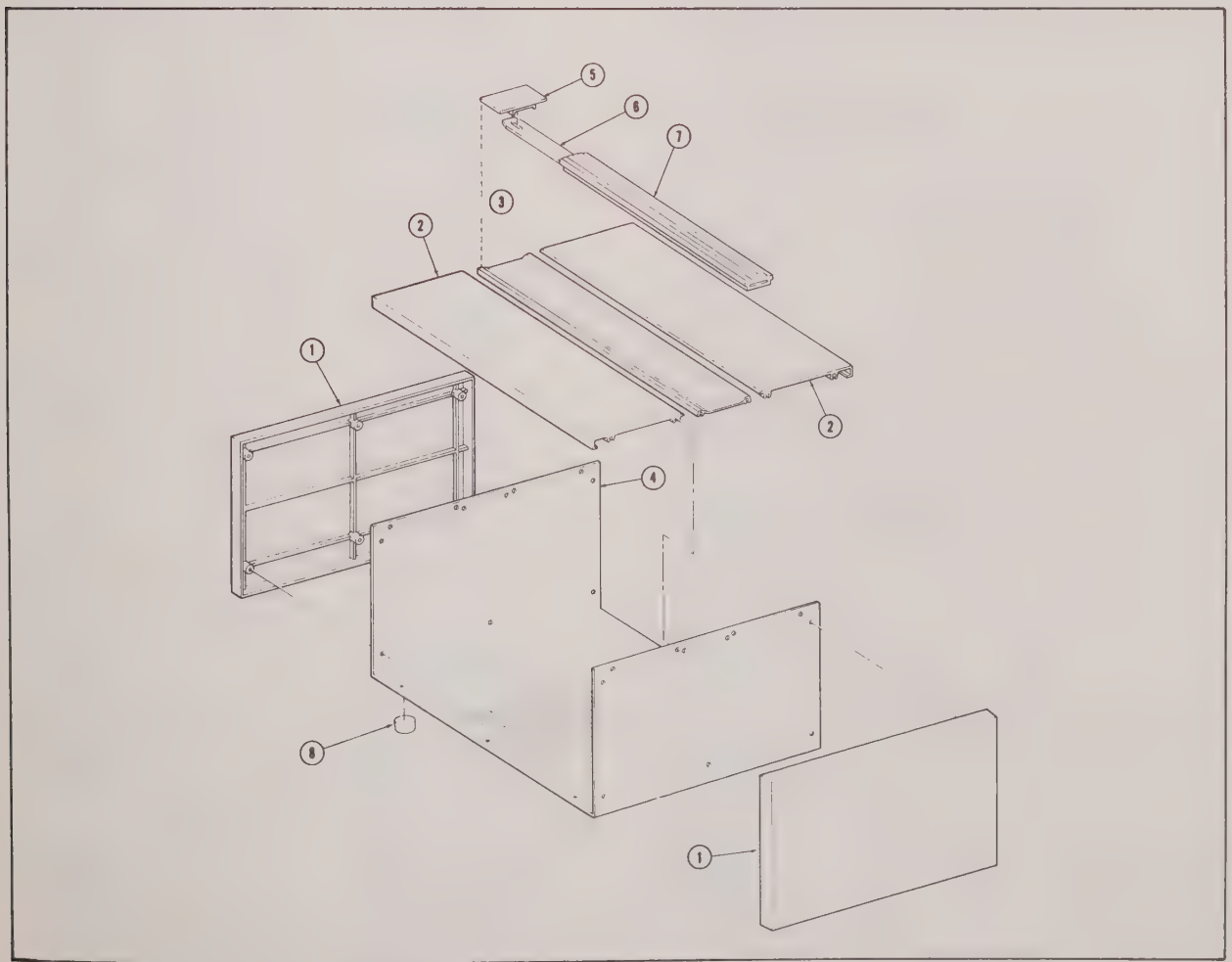


FIGURE 8-7 CASE ASSEMBLY (886139)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
RECORDER CONTROL BOARD ASSY (886394)
FIGURE 8-8

ITEM NO	PART NUMBER	DESCRIPTION
C101	240352-502	Capacitor
C103, C104	262585-106	Capacitor
C105	35-281295-228	Capacitor
C106	263386-108	Capacitor
C107	262585-106	Capacitor
C108	5-241145-124	Capacitor
C109	10-247116-153	Capacitor
†CR103	231887	Semiconductor, Diode
†CR104	246107	Semiconductor, Diode IN746
†CR105	249747	Semiconductor, Diode 1N752
†CR106	280440	Semiconductor, Diode 1N752
†CR107, CR108	286018-1	Semiconductor, Diode 1N752
†CR109	286692-1	Semiconductor
†CR110 Thru †CR113	231887	Semiconductor, Diode
†F101, F102	116198-6	Fuse, ¼ amp
J101 Thru J104	281711-16	Connector
J105-1, 2	281711-4	Connector
J107	281711-8	Connector
†K101	285588	Relay
†Q101	281703-2	Semiconductor, 2N4403
†Q102	281702-2	Semiconductor, 2N4401
†Q103	281703-2	Semiconductor, 2N4403
†Q104	268925	Semiconductor, 2N4870
†Q105 †Thru †Q112	268934-2	Semiconductor
†R101	284878-503	Resistor, Variable
R102	5-241111-182	Resistor
R104	5-241111-471	Resistor
R105	5-241111-103	Resistor
R106	5-241111-124	Resistor
R107	5-241111-622	Resistor
R108	5-241111-122	Resistor
R109	5-241111-271	Resistor
R110	5-241111-223	Resistor
R111	5-241111-682	Resistor

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
RECORDER CONTROL BOARD ASSY (886394)
FIGURE 8-8

ITEM NO	PART NUMBER	DESCRIPTION
R112	5-241111-124	Resistor
R113	5-241111-182	Resistor
R114	5-241111-334	Resistor
R115	5-241111-472	Resistor
R116	5-115558-680	Resistor
†R117	284878-503	Resistor, Variable
R118	5-241111-101	Resistor
R119	5-241111-103	Resistor
R122	5-241111-102	Resistor
R123	5-241111-473	Resistor
R124 Thru R127	5-115559-330	Resistor
R128	5-241111-103	Resistor
R129	5-241111-473	Resistor
R130	5-241111-681	Resistor
R131	5-241111-103	Resistor
R132	5-241111-473	Resistor
R133	5-241111-681	Resistor
R134	5-241111-103	Resistor
R135	5-241111-473	Resistor
R136	5-241111-681	Resistor
R137	5-241111-103	Resistor
R138	5-241111-473	Resistor
R139	5-241111-681	Resistor
R140	5-115558-221	Resistor
R142	5-241111-471	Resistor
†S-103	286423	Switch
†T101	286402	Transformer
†T102	285775-1	Transformer
†U101	230062-1	Semiconductor
†U102	285589	Semiconductor 4N28
†U103	286158-1	Semiconductor CMOS
†U104	284684	Semiconductor CMOS
†U105, U106	284681	Semiconductor CMOS

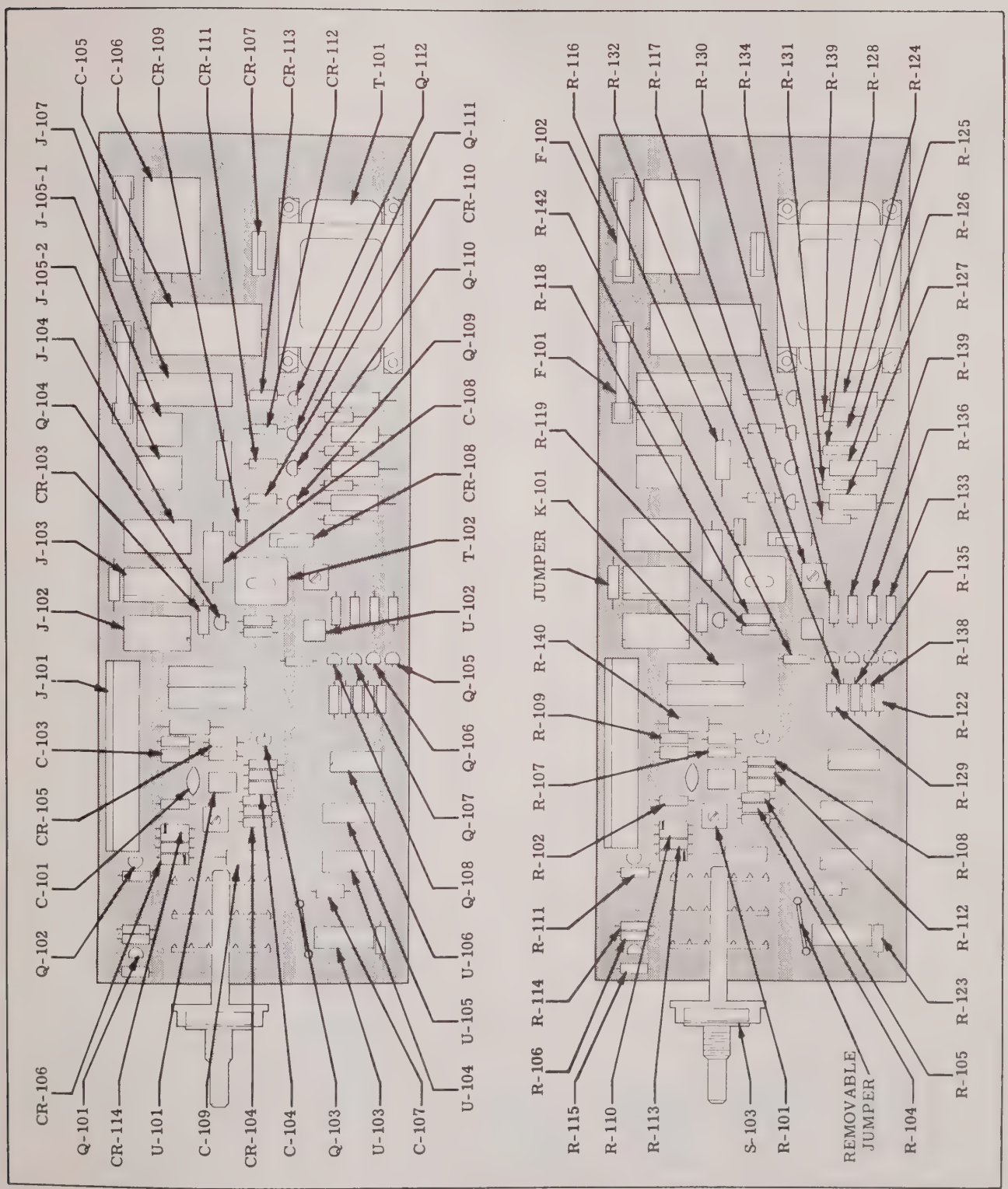
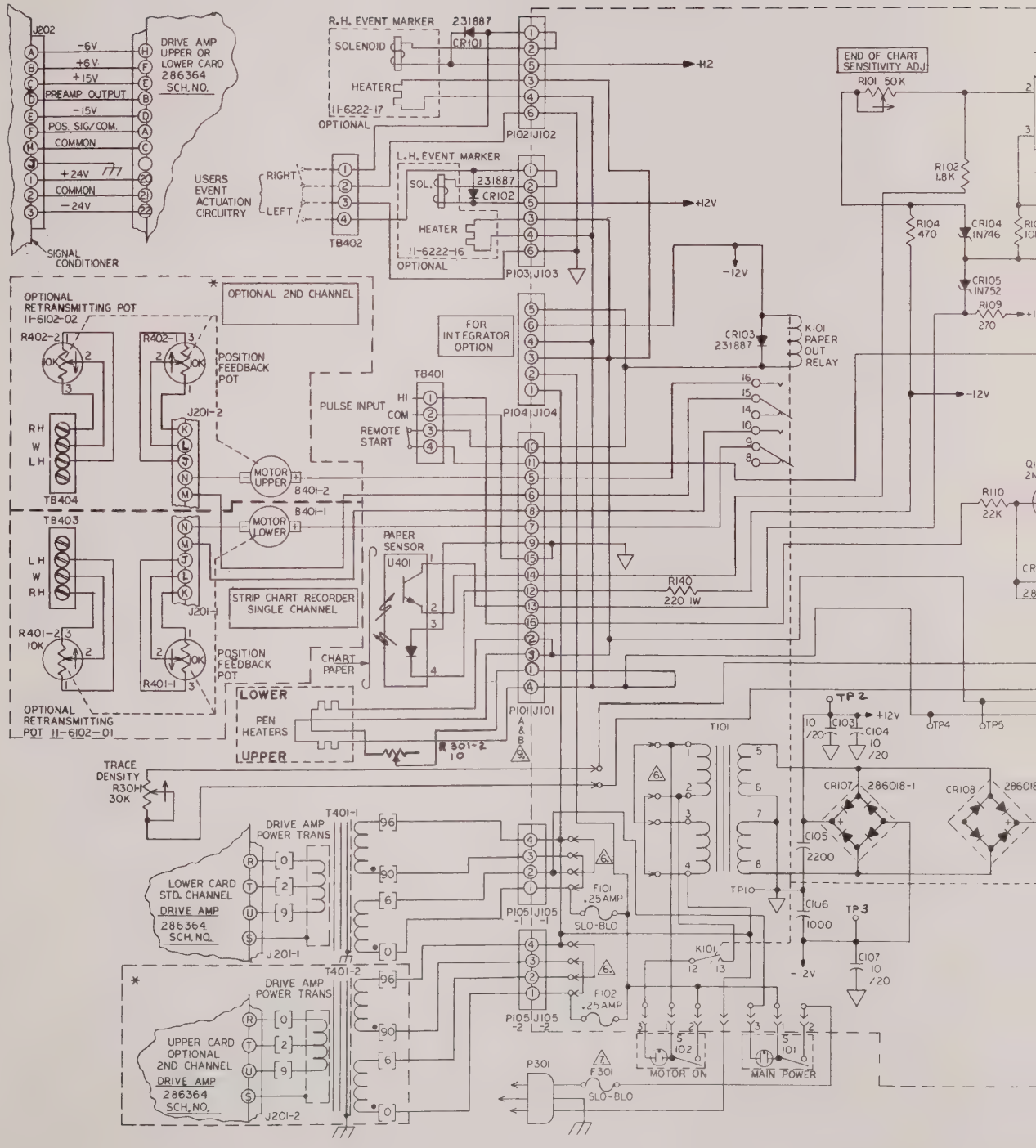
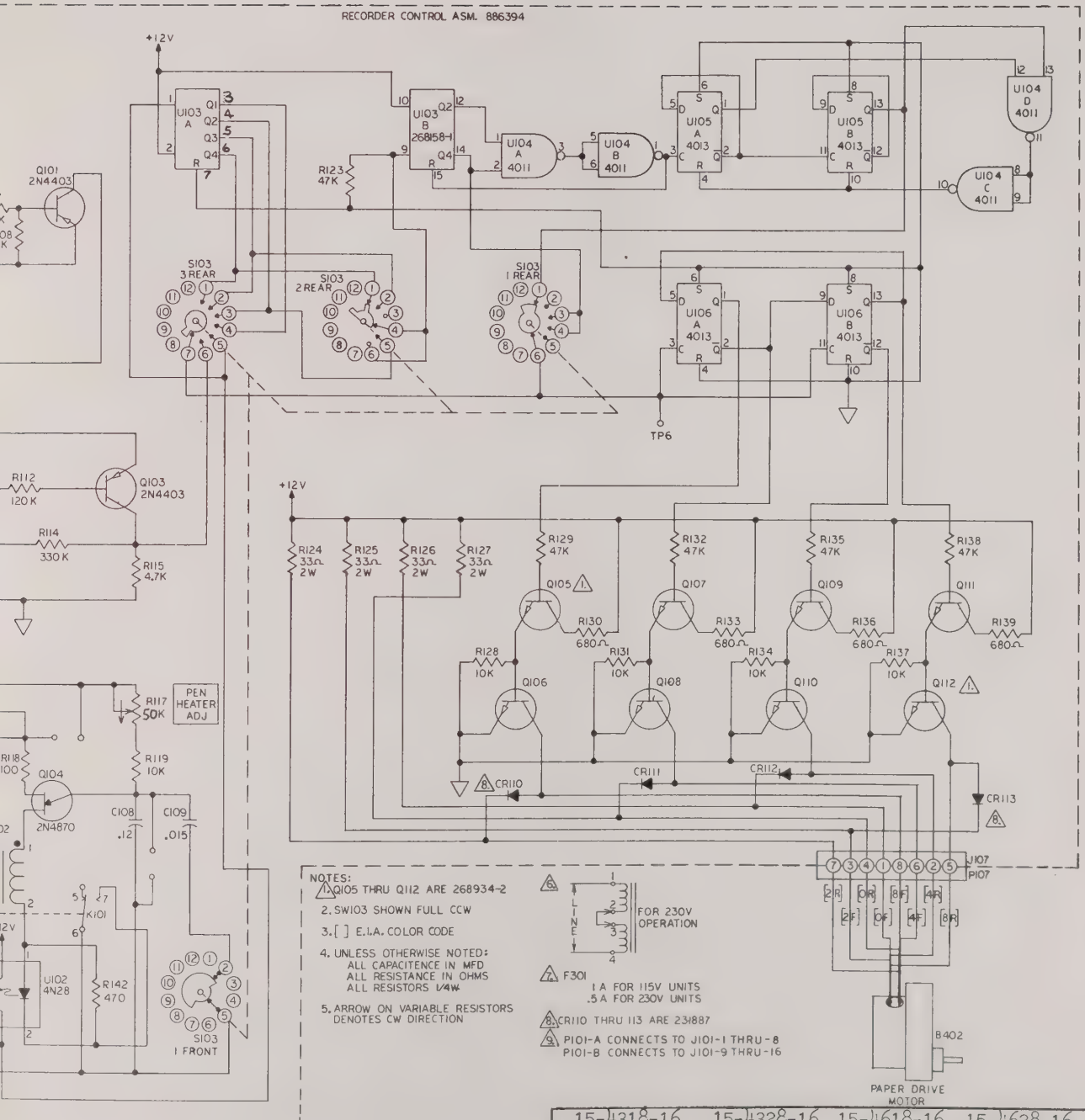


FIGURE 8-8 RECORDER CONTROL BOARD ASSEMBLY (886394)


J202
-6V
+6V
+15V
PREAMP OUTPUT
-15V
POS. SIG/COM.
COMMON
+24V
COMMON
-24V
SIGNAL CONDITIONER
DRIVE AMP UPPER OR LOWER CARD 286364 SCH. NO.
USERS EVENT ACTUATION CIRCUITRY
RIGHT
LEFT
TB402
R.H. EVENT MARKER
231887
CR101
SOLENOID
HEATER
11-6222-17
OPTIONAL
L.H. EVENT MARKER
SOL.
231887
CR102
HEATER
11-6222-16
OPTIONAL
P102 J102
P103 J103
+12
+12V
-12V
END OF CHART SENSITIVITY ADJ.
R101 50K
R102 1.8K
R104 470
CR104 IN746
CR105 IN752
R109 270
CR103 231887
K101 PAPER OUT RELAY
FOR INTEGRATOR OPTION
OPTIONAL RETRANSMITTING POT 11-6102-02
R402-2
R402-1
10K
POSITION FEEDBACK POT
RH
W
LH
TB404
J201-2
OPTIONAL 2ND CHANNEL
TB401
PULSE INPUT
HI
COM
REMOTE START
P104 J104
MOTOR UPPER
MOTOR LOWER
B401-2
B401-1
TB403
R401-2
R401-1
J201-1
STRIP CHART RECORDER SINGLE CHANNEL
PAPER SENSOR
U401
CHART PAPER
R140 220 1W
R110 22K
OPTIONAL RETRANSMITTING POT 11-6102-01
LOWER
PEN HEATERS
UPPER
R301-2 10
P101 J101 A & B
TRACE DENSITY R301-1 30K
T401-1
DRIVE AMP POWER TRANS
LOWER CARD STD. CHANNEL DRIVE AMP 286364 SCH. NO.
J201-1
T401-2
UPPER CARD OPTIONAL 2ND CHANNEL DRIVE AMP 286364 SCH. NO.
J201-2
P105 J105 -1
P105 J105 -2
F101 .25AMP SLO-BLO
F102 .25AMP SLO-BLO
F301 SLO-BLO
P301
K101
MOTOR ON
MAIN POWER
T101
TP1
TP2
TP3
TP4
TP5
C103 10 /20
C104 10 /20
C105 2200
C106 1000
C107 10 /20
CR107 286018-1
CR108 286018

REV-C3

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL



NOTES:

1. Q105 THRU Q112 ARE 268934-2
2. SW103 SHOWN FULL CCW
3. [ ] E.I.A. COLOR CODE
4. UNLESS OTHERWISE NOTED:
   ALL CAPACITENCE IN MFD
   ALL RESISTANCE IN OHMS
   ALL RESISTORS 1/4W
5. ARROW ON VARIABLE RESISTORS DENOTES CW DIRECTION

6. FOR 230V OPERATION
7. F301
   1 A FOR 115V UNITS
   .5 A FOR 230V UNITS
8. CR110 THRU 113 ARE 23887
9. P101-A CONNECTS TO J101-1 THRU-8
   P101-B CONNECTS TO J101-9 THRU-16

15-4318-16	15-4328-16	15-4618-16	15-4628-16
15-4318-10	15-4328-10	15-4618-10	15-4628-10
15-4318-06	15-4328-06	15-4618-06	15-4628-06
15-4318-00	15-4328-00	15-4618-00	15-4628-00

RECORDER ASS'Y., 10 INCH STRIP CHART

BY	DATE
DR SNOWDEN	5/74
PL POLLY	5/74
MC CAHAN	5/74

NAME: SCHEMATIC
MODEL NO., SEE TAB.

CODE IDENT. 96795 | ISSUE CODE G

Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

DWG NO. 286363

FIGURE 8-9 RECORDER CONTROL SCHEMATIC (286363)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
DRIVE AMPLIFIER BOARD ASSY (886046-1 & -2)
FIGURE 8-10

ITEM NO	PART NUMBER	DESCRIPTION
C201, C202	35-281295-228	Capacitor
C203, C204	262585-106	Capacitor
C205	240352-102	Capacitor
C206, C207	262585-106	Capacitor
C208 Thru C210	240352-102	Capacitor
C211	240352-101	Capacitor
C212	5-241145-104	Capacitor
C213	240352-101	Capacitor
C214	240352-102	Capacitor
C215	240352-101	Capacitor
C216	10-241145-103	Capacitor
C217	240352-101	Capacitor
C218, C219	240352-301	Capacitor
C220 Thru C231	262585-106	Capacitor
C232	240352-101	Capacitor
†CR201	265420-1	Semiconductor, Bridge
†CR202, CR203	230061-3	Semiconductor, Diode
†CR204	280435-2	Semiconductor, Diode
†CR205, CR206	280440	Semiconductor, Diode
†CR207, CR208	244896	Semiconductor, Diode
†CR209, CR210	280440	Semiconductor, Diode
†CR211, CR212	269256-7	Semiconductor, Diode
†Q201	2-230057-1	Semiconductor
†Q202	2-230058-1	Semiconductor
†Q203	242323	Semiconductor
†Q204	247149	Semiconductor
†Q205	242323	Semiconductor
†Q206	247149	Semiconductor
†Q207	283658-2	Semiconductor
†Q208	268934-2	Semiconductor
†Q209	2-230058-3	Semiconductor
†Q210	2-230057-3	Semiconductor
R201, R202	5-115557-390	Resistor
R203, R204	5-241111-681	Resistor
R205, R206	5-115557-221	Resistor
R207	5-241111-105	Resistor
R208	5-241111-332	Resistor
R209	5-241111-472	Resistor
R210	5-241111-751	Resistor

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
DRIVE AMPLIFIER BOARD ASSY (886046-1 & -2)
FIGURE 8-10

ITEM NO	PART NUMBER	DESCRIPTION
R211	25-284694-53000	Resistor
†R212	282299-102	Resistor, Variable
R213	25-284694-57000	Resistor
R214	25-284694-10001	Resistor
†R215	282299-500	Resistor, Variable
R216, R217	25-284694-10001	Resistor
R218	25-284694-50001	Resistor
R219	25-284694-30002	Resistor
†R220	282299-103	Resistor, Variable
R221	25-284694-12002	Resistor
R222	25-284694-11502	Resistor
R223	25-284694-78000	Resistor
†R224	282299-502	Resistor, Variable
R225	5-241111-512	Resistor
†R226	282299-203	Resistor, Variable
R227	25-265969-90001	Resistor
R228	5-241111-154	Resistor
†R229	282299-103	Resistor, Variable
R230	25-265969-10003	Resistor (886046-1)
	25-265969-27002	Resistor (886046-2) (For use with integrator)
R231	25-284694-96001	Resistor
R232	25-284694-90001	Resistor (886046-1)
	25-284694-72001	Resistor (886046-2) For use with integrator)
R233	5-241111-154	Resistor
R234	5-241111-303	Resistor
R235	25-265969-15001	Resistor
R236	5-241111-154	Resistor
R237	5-241111-623	Resistor
R238	5-241111-104	Resistor
R239	5-241111-103	Resistor
R240	5-241111-221	Resistor
R241	5-241111-683	Resistor
R242	5-241111-105	Resistor
R243	5-241111-243	Resistor
R244	5-241111-751	Resistor
R245	5-241111-243	Resistor
R246	5-241111-331	Resistor

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
DRIVE AMPLIFIER BOARD ASSY (886046-1 & -2)
FIGURE 8-10

ITEM NO	PART NUMBER	DESCRIPTION
R247	5-241111-222	Resistor
R248	5-115558-221	Resistor
R249	5-115557-331	Resistor
R250, R251	5-241111-100	Resistor
R252, R253	5-115557-120	Resistor
†R254	282299-502	Resistor, Variable
†U201 †Thru †U209	280863-3	Semiconductor

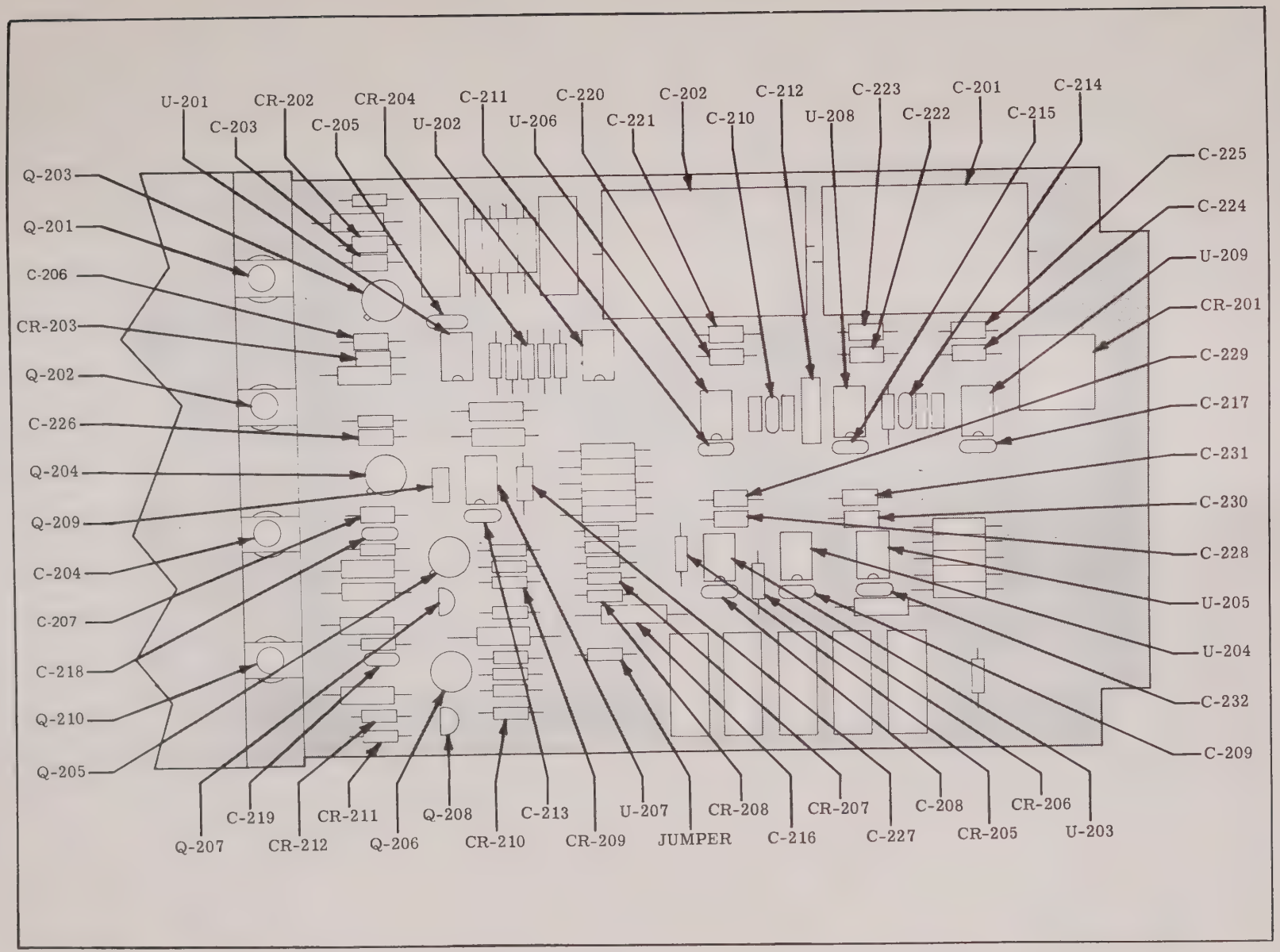


FIGURE 8-10 DRIVE AMPLIFIER BOARD ASSY (886046) (Sheet 1 of 2)

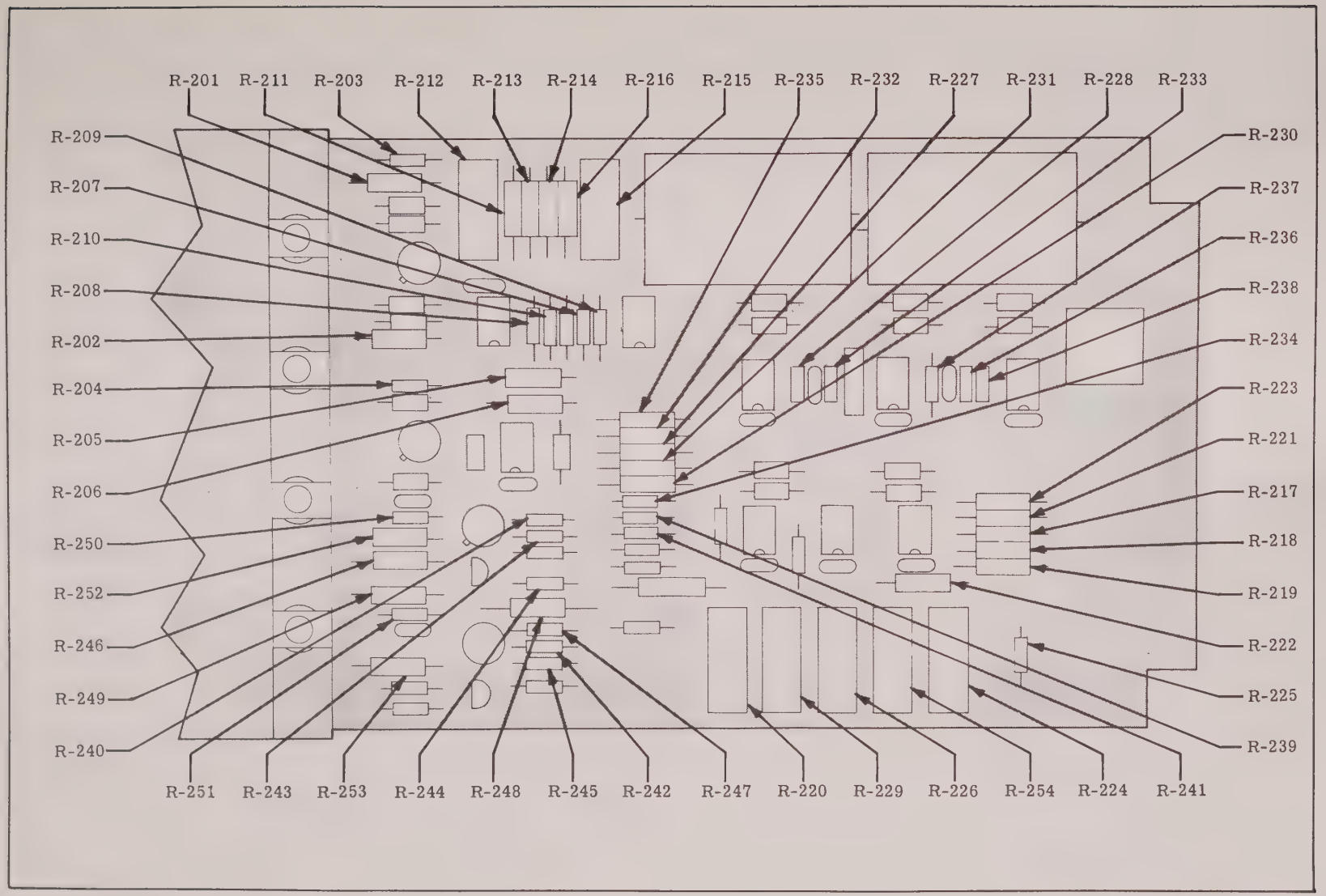
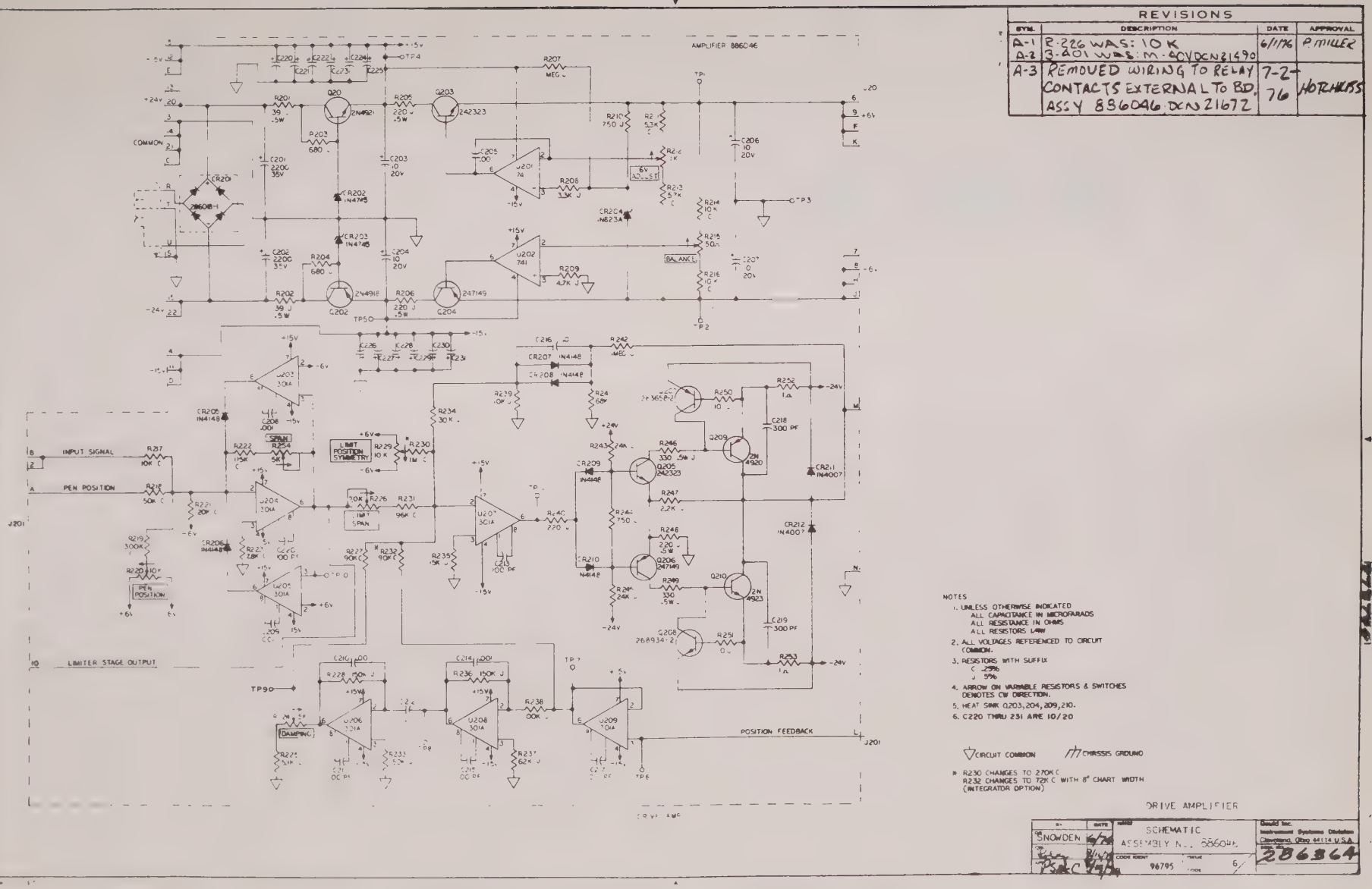


FIGURE 8-10 DRIVE AMPLIFIER BOARD ASSY (886046) (Sheet 2 of 2)



NOTES
1. UNLESS OTHERWISE INDICATED
   ALL CAPACITANCE IN MICROFARADS
   ALL RESISTANCE IN OHMS
   ALL RESISTORS 1/4W
2. ALL VOLTAGES REFERENCED TO CIRCUIT COMMON.
3. RESISTORS WITH SUFFIX
   C ±2%
   J 5%
4. ARROW ON VARIABLE RESISTORS & SWITCHES DENOTES CW DIRECTION.
5. HEAT SINK Q203, 204, 209, 210.
6. C220 THRU 231 ARE 10/20

▽ CIRCUIT COMMON ⏚ CHASSIS GROUND

* R230 CHANGES TO 270K Ω
  R232 CHANGES TO 72K Ω WITH 8" CHART WIDTH (INTEGRATOR OPTION)

FIGURE 8-11 DRIVE AMPLIFIER SCHEMATIC (286364)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INPUT SIGNAL COUPLER 13-4715-08
FIGURE 8-12

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	285651-6	Knob, Offset Control	
2	286006-10	Post, Binding (low)	J302
3	286006-2	Post, Binding (hi)	J301
4	687555	Panel Assy	
5	243898-82	Nut, Asm. Lockwasher	
6	786040	Bracket Assy	
7	286094	Bracket, Potentiometer Mtg.	
†8	10-285474-103	Resistor, Vari	R108
9	787585	Board Assy, Coupler (See Fig. 8-13)	
10	861810-364	Cable Assy	
11	247523-121	Plate, Ident.	
12	241930-3	Contact, Elec.	
13	243898-62	Nut, Asm. Lockwasher	
14	286083	Bracket, Terminal Mtg.	
15	1-216886-303	Block, Terminal	

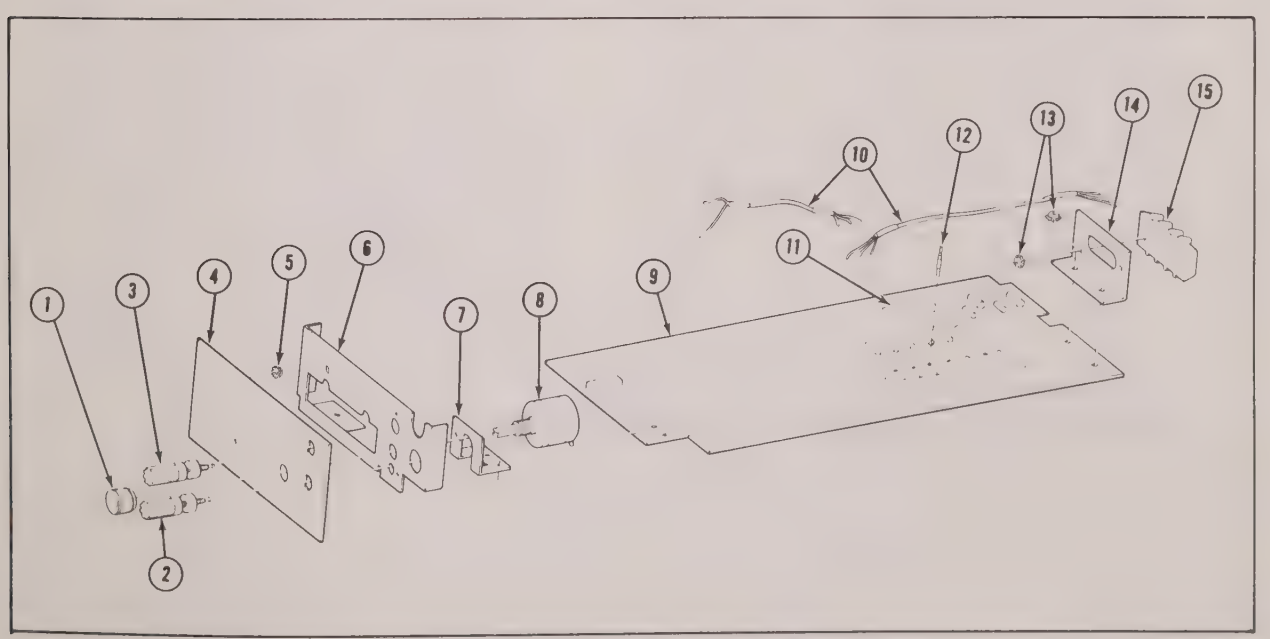


FIGURE 8-12 INPUT SIGNAL COUPLER 13-4715-08

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INPUT SIGNAL COUPLER BOARD ASSY 787585
FIGURE 8-13

ITEM NO	PART NUMBER	DESCRIPTION
C-101	262956-226	Capacitor (22 microfarads)
C-102	262956-226	Capacitor (22 microfarads)
†R-101	268940-502	Resistor, Vari ("Trim" Pot)
R-102	25-265969-75000	Resistor (7.5K)
R-103	25-265969-30001	Resistor (30K)
R-104	25-265969-50001	Resistor (50K)
R-105	25-265969-10002	Resistor (100K)
R-106	25-265969-50001	Resistor (300K)
R-107	25-265969-50002	Resistor (50K)

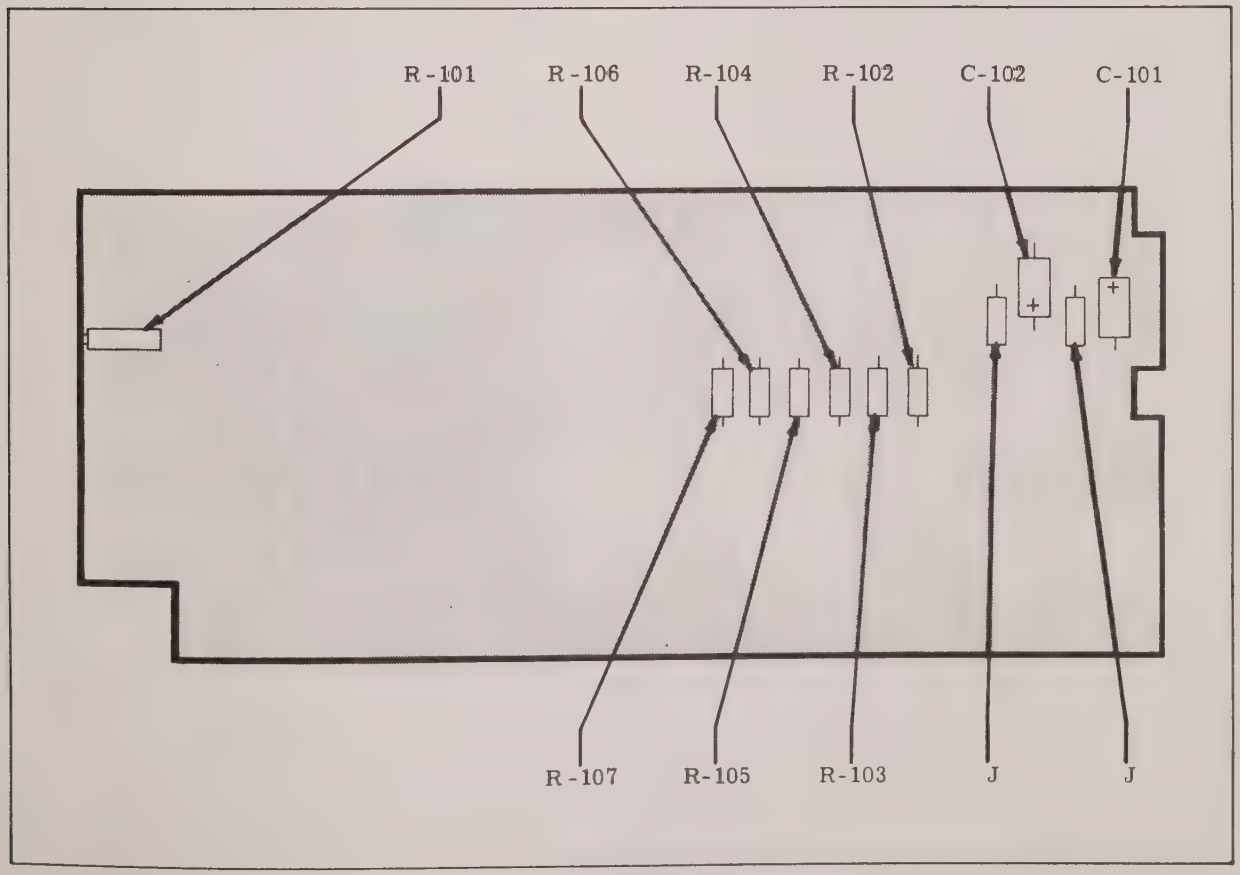


FIGURE 8-13 INPUT SIGNAL COUPLER BOARD ASSY (787585)

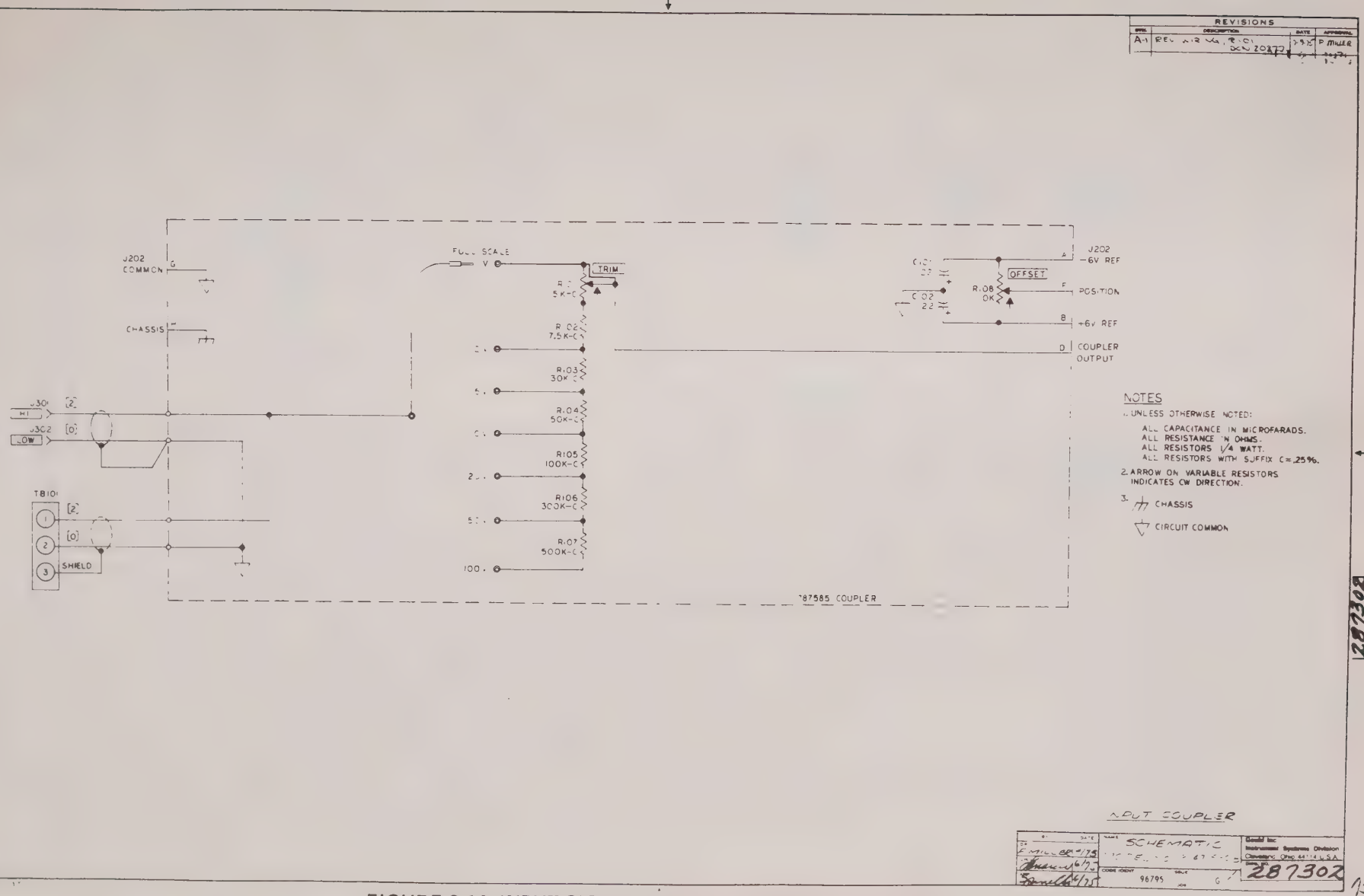


FIGURE 8-14 INPUT SIGNAL COUPLER SCHEMATIC (287302)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
FIXED SPAN DC AMPLIFIER (13-4715-07)
FIGURE 8-15

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	285651-6	Knob, Control	
2	286006-6	Post, Binding	J303
3	286006-10	Post, Binding	J302
4	286006-2	Post, Binding	J301
5	11-4601-XX	Plug in Fixed Gain (16 Available)	
6	686043	Panel Assy	
7	786040	Bracket Assy	
8	243898-82	Nut Assy	
9	286094	Bracket Mtg, Pot	
†10	10-285474-103	Resistor, Var.	R106
11	886021	Board Assy, Amp (See Figure 8-16)	
12	———	Not Used	
13	270903-6	Clamp	
14	861810-364	Cable Assy	
15	243898-62	Nut Assy	
16	286083	Bracket Mtg.	
17	1-216886-303	Block, Terminal	
18	247523-97	Plate, Ident.	

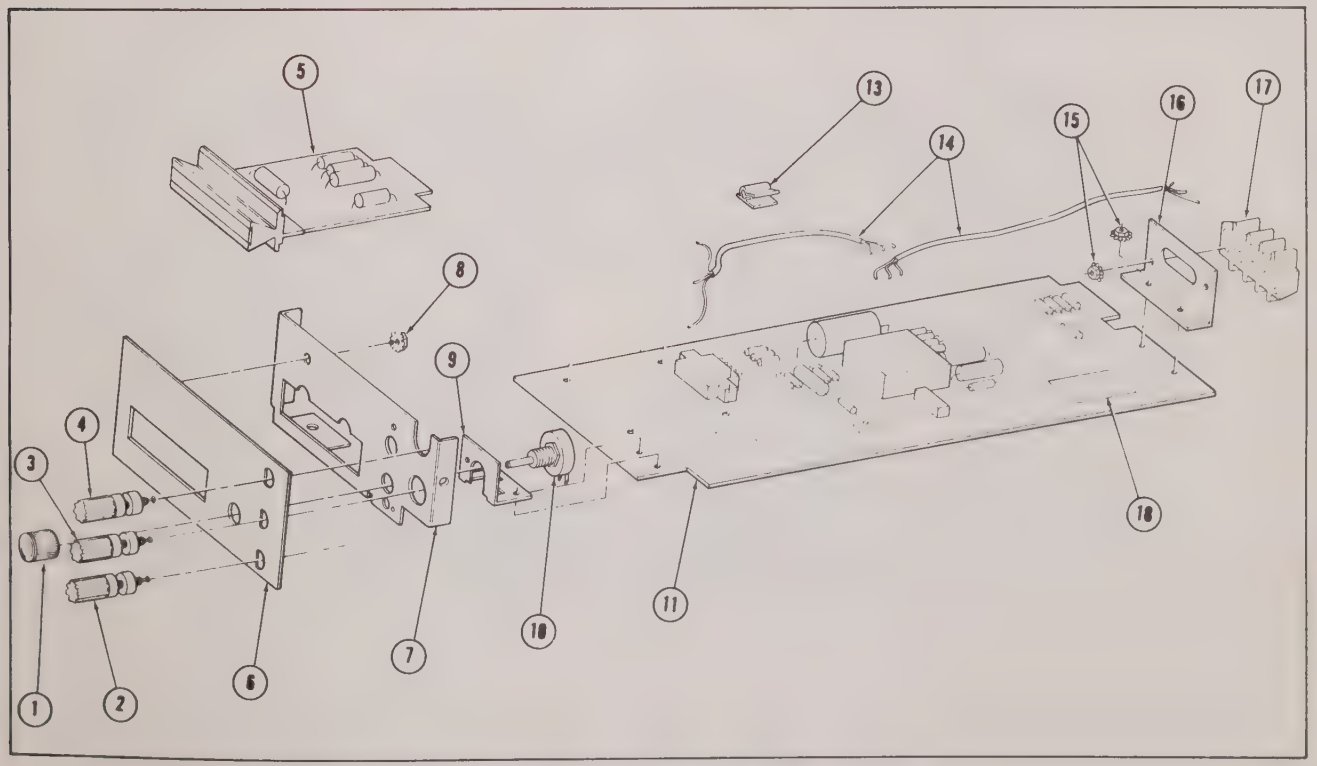


FIGURE 8-15 FIXED SPAN DC AMPLIFIER (13-4715-07)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
FIXED SPAN AMPLIFIER BOARD ASSY (886021)
FIGURE 8-16

ITEM NO	PART NUMBER	DESCRIPTION
C102, C103	231922-107	Capacitor
C104	10-241145-325	Capacitor
C105, C106	262956-226	Capacitor
CR101, CR102	281845-6	Semiconductor, Diode
J101	285940-8	Connector
R101	5-285473-50000	Resistor
R102	5-241111-105	Resistor
R103	5-241111-103	Resistor
†R104	282299-503	Resistor, Variable
R105	5-241111-104	Resistor
R107, R108	5-241111-101	Resistor
†U101	284877	Semiconductor, I.C.

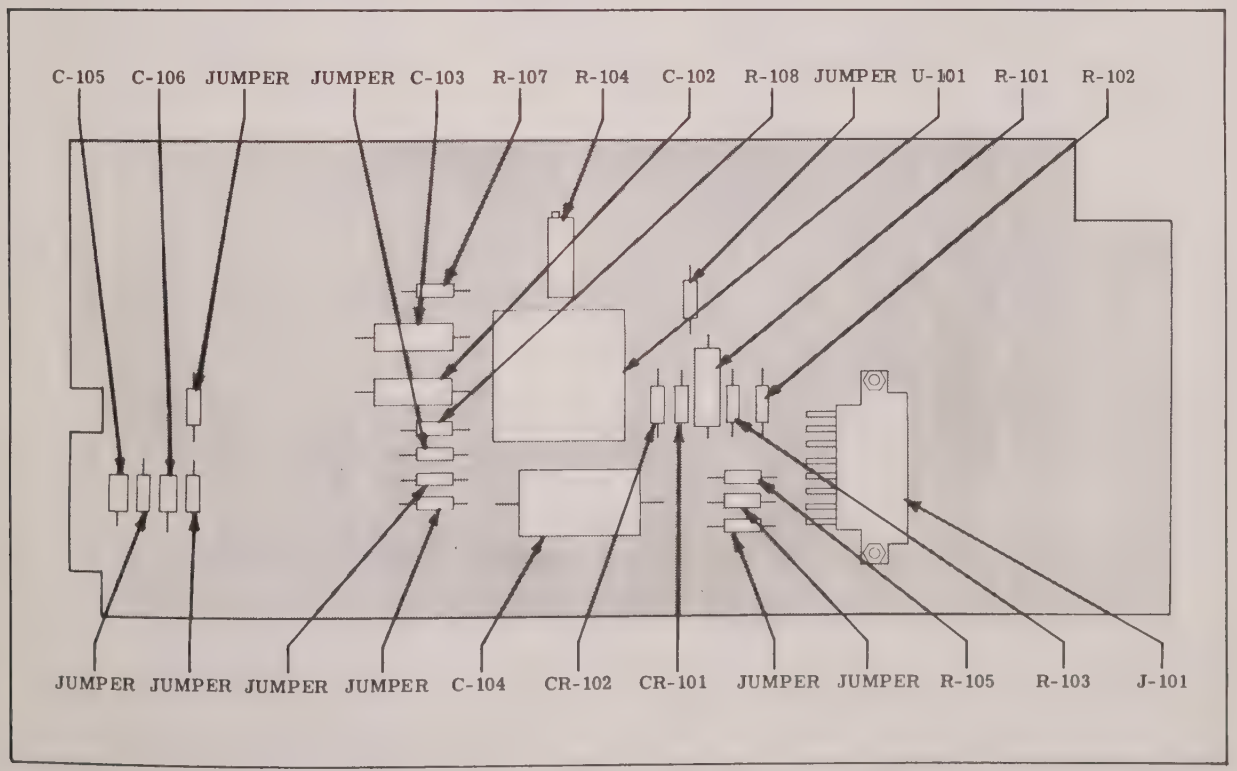


FIGURE 8-16 FIXED SPAN AMPLIFIER BOARD ASSY (886021)

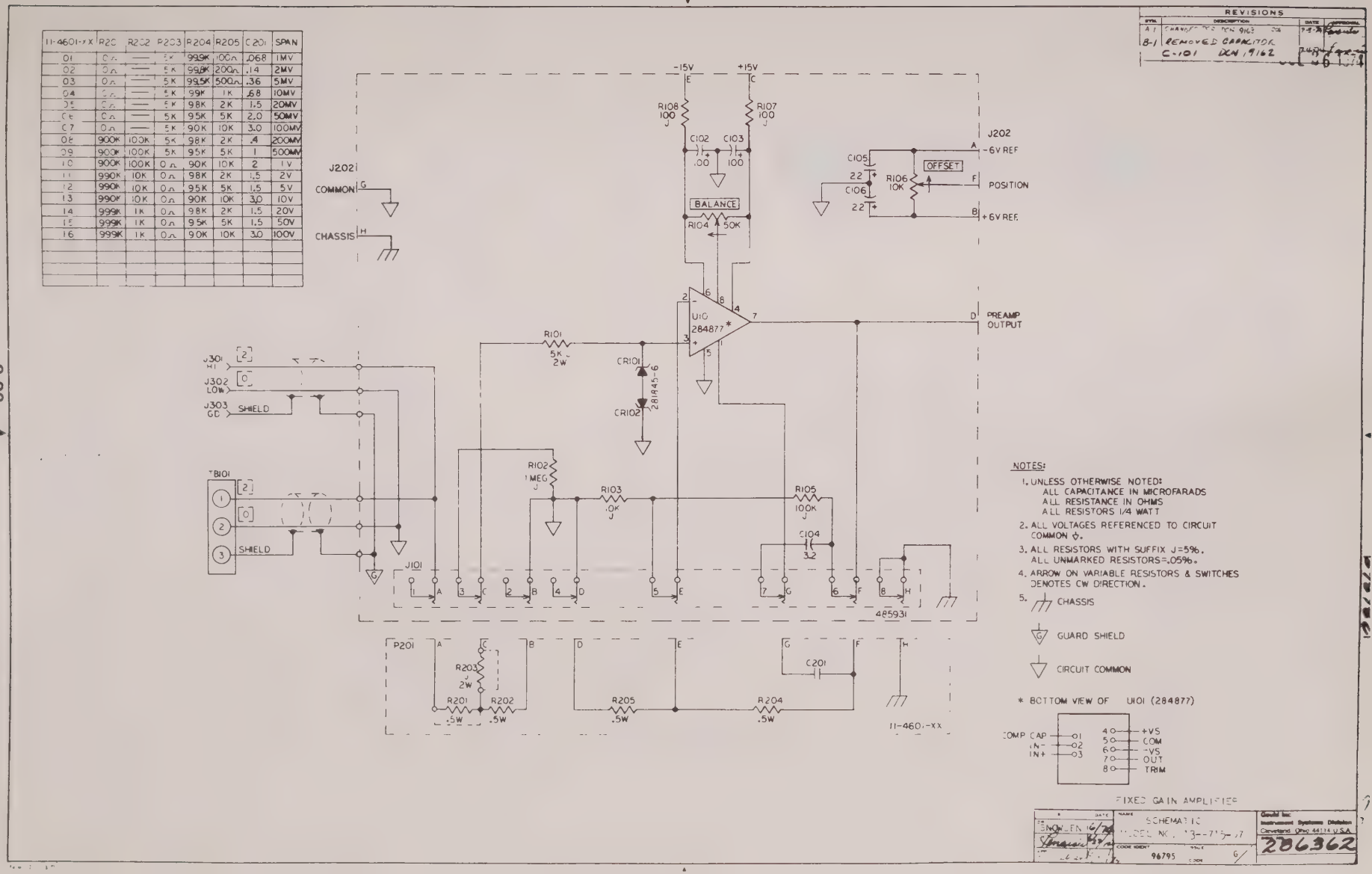


FIGURE 8-17. FIXED SPAN AMPLIFIER SCHEMATIC (286362)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
HIGH GAIN MULTI-SPAN AMPLIFIER ASSY (13-4715-06)
FIGURE 8-18

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	286006-6	Post, Binding (Blue)	J203
2	286006-10	Post, Binding (Black)	J202
3	286006-2	Post, Binding (Red)	J201
4	284990	Knob, Turns Counterclockwise	
5	285650	Knob, Control	
6	285651-2	Knob, Control	
7	285653-1	Knob, Control	
8	684931	Panel Assy	
9	786040	Bracket, Assy	
†10	269094-103	Resistor, Variable	R201
11	861810-364	Cable Assy	
12	885981	Board Assy, Amp (See Figure 8-19)	
13	247523-96	Plate, Ident	
14	243898-62	Nut Assy	
15	286083	Bracket, Term, Mtg	
16	1-216886-303	Block, Term	
†17	268921	Switch, Toggle	S201

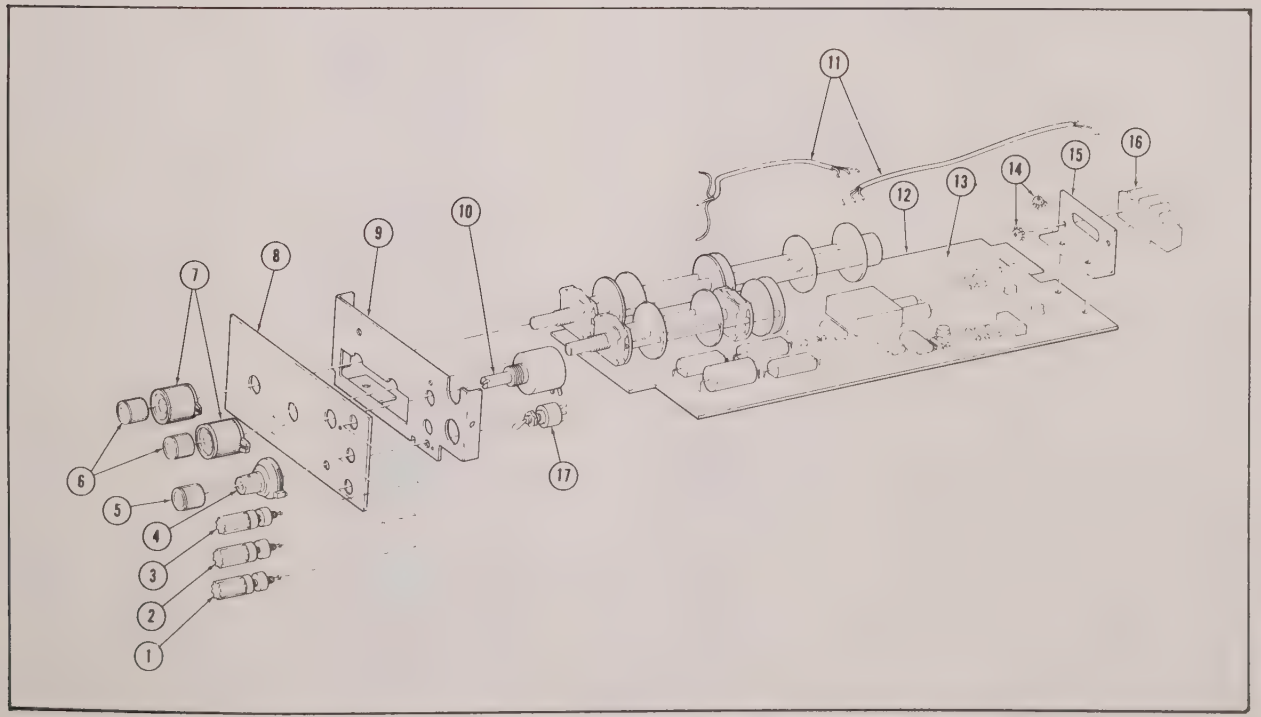


FIGURE 8-18 HIGH GAIN MULTI-SPAN AMPLIFIER ASSY (13-4715-06)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
HIGH GAIN MULTI-SPAN AMPLIFIER BOARD ASSY (885981)
FIGURE 8-19

ITEM NO	PART NUMBER	DESCRIPTION
C101	5-241145-204	Capacitor
C102, C103	269255-107	Capacitor
C104	5-241145-105	Capacitor
C105	5-241145-254	Capacitor
C106, C107	5-241145-203	Capacitor
C108	5-241145-645	Capacitor
C109	5-241145-295	Capacitor
C110	5-241145-195	Capacitor
C111	5-241145-144	Capacitor
C112	240352-202	Capacitor
C113	5-241145-485	Capacitor
C114	5-241145-225	Capacitor
C115	5-241145-155	Capacitor
C116	5-241145-104	Capacitor
C118, C119	262956-226	Capacitor
†CR101, CR102	281845-6	Semiconductor, Diode
R101	5-284693-99502	Resistor
R102	5-285473-50000	Resistor
R103	5-285473-50000	Resistor
R104	5-284693-50000	Resistor
R105, R106	5-241111-101	Resistor
†R107	282299-502	Resistor, Variable
†R108	282299-503	Resistor, Variable
R109	25-265969-50001	Resistor
R110	285541	Switch
R111	5-284693-80001	Resistor
R112	5-284693-10001	Resistor
R113	5-284693-50000	Resistor
R114	5-284693-30000	Resistor
R115	5-284693-30000	Resistor
R116	5-284693-500R0	Resistor
R117	5-284693-300R0	Resistor
R118	5-284693-100R0	Resistor
R119	5-284693-50R00	Resistor
R120	R05-246659-30R00	Resistor
R121, R122	R05-246659-10R00	Resistor
R123	25-265969-10001	Resistor
R124	25-265969-40001	Resistor

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
HIGH GAIN MULTI-SPAN AMPLIFIER BOARD ASSY (885981)
FIGURE 8-19

ITEM NO	PART NUMBER	DESCRIPTION
R125	25-265969-50001	Resistor
R126	5-241111-104	Resistor
R127, R128	R1-284694-10001	Resistor
R129	5-241111-512	Resistor
R130	R1-284694-40000	Resistor
R131	R1-284694-60360	Resistor
R132	R1-284694-10003	Resistor
R133, R134	R1-284694-83302	Resistor
†R135	282299-204	Resistor, Variable
R136	R1-284694-90002	Resistor
R137, R138	R1-284694-83302	Resistor
†S101	285541	Switch
†S102	285520	Switch
†U101	284877	Amplifier
†U102	281101	Semiconductor, Amplifier
†U103	280863-1	Semiconductor, Amplifier
†U104	230062	Semiconductor, Amplifier

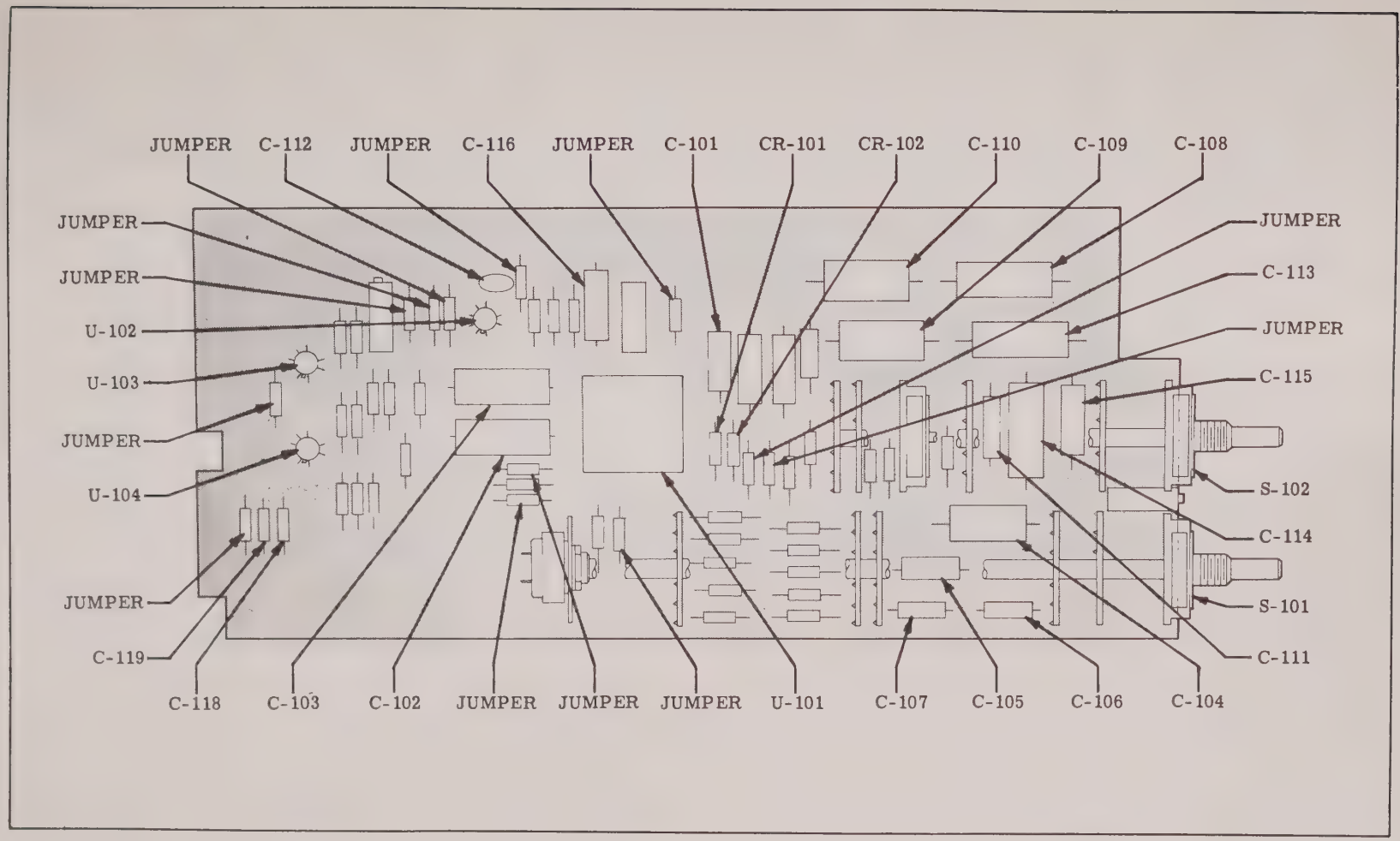


FIGURE 8-19 HIGH GAIN MULTI SPAN AMPLIFIER BOARD ASSY (885981) (Sheet 1 of 2)

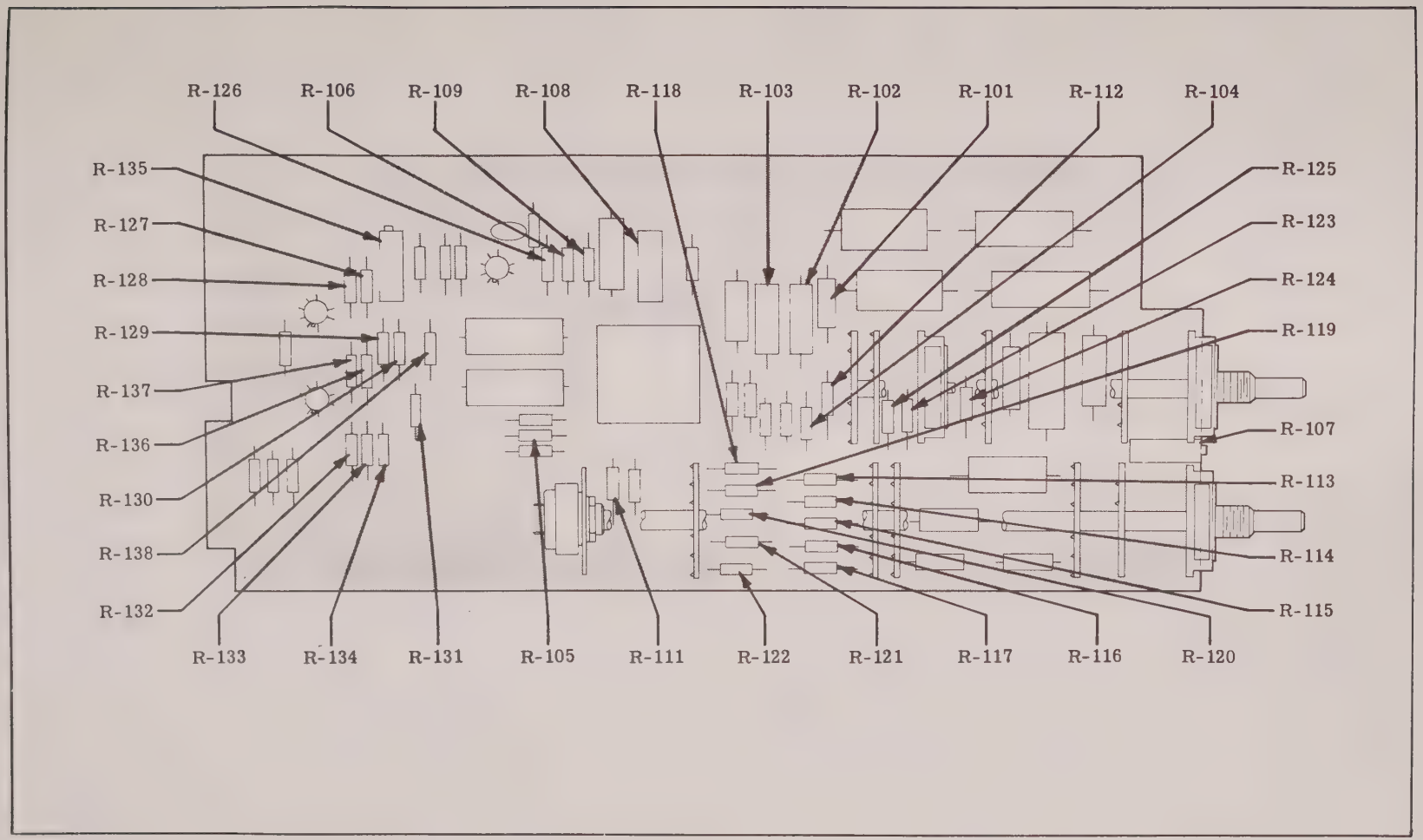
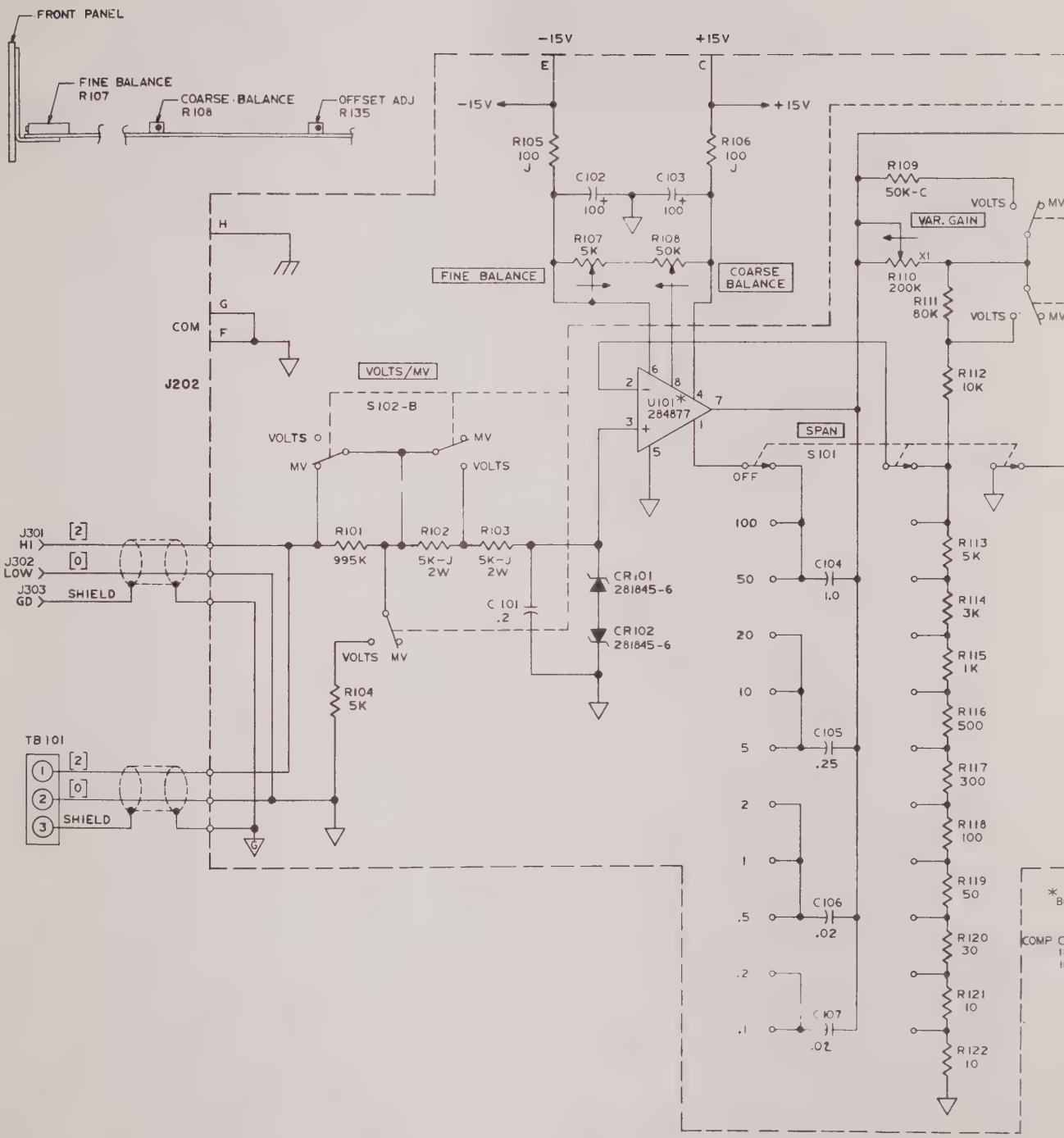
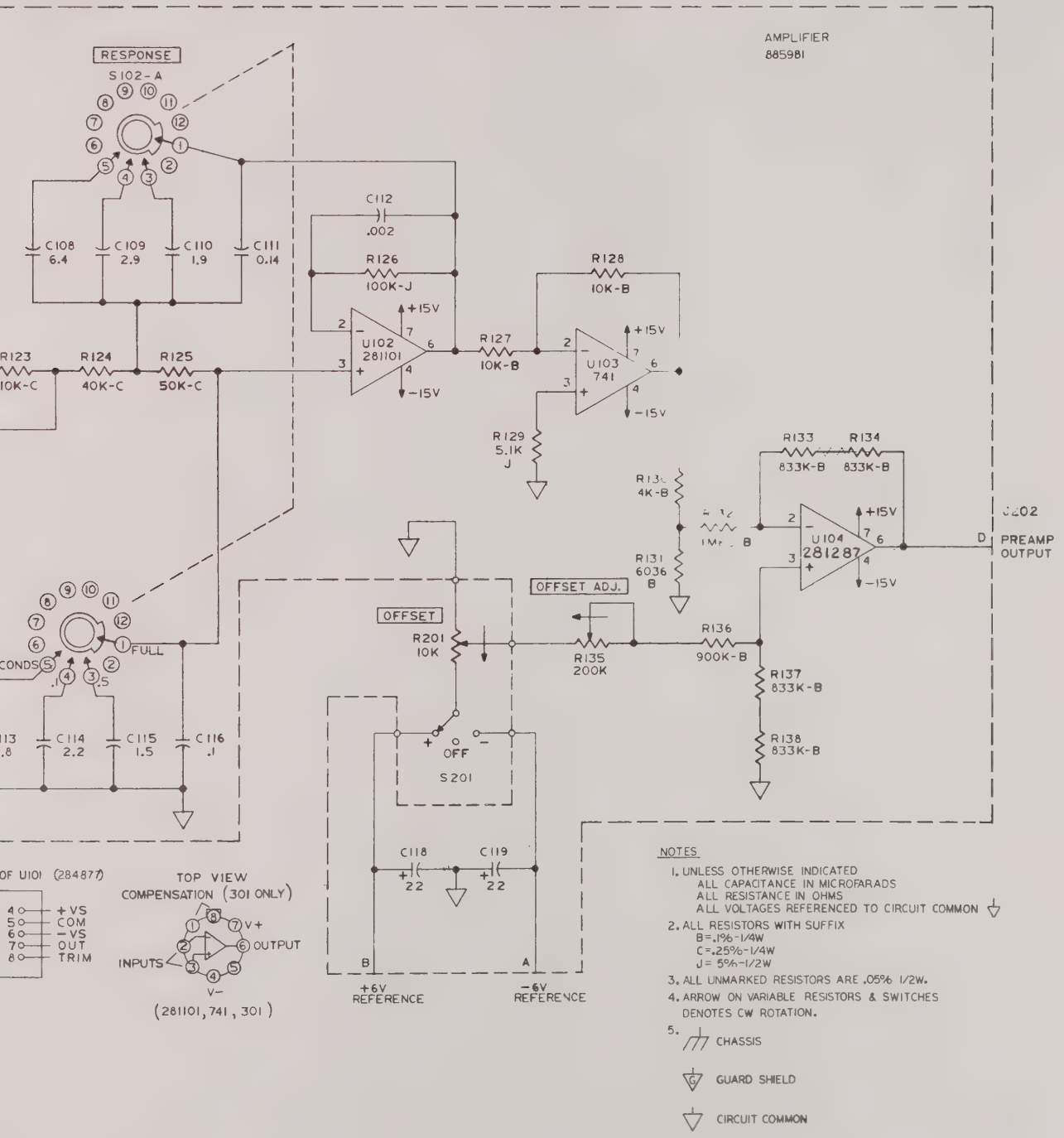


FIGURE 8-19 HIGH GAIN MULTI SPAN AMPLIFIER BOARD ASSY (885981) (Sheet 2 of 2)


FRONT PANEL
FINE BALANCE R107
COARSE BALANCE R108
OFFSET ADJ R135
-15V
+15V
E
C
R105 100 J
R106 100 J
C102 100
C103 100
R107 5K
R108 50K
FINE BALANCE
COARSE BALANCE
H
G
COM
F
J202
VOLTS/MV
S102-B
VOLTS
MV
U101 * 284877
R109 50K-C
VAR. GAIN
X1
R110 200K
R111 80K
R112 10K
SPAN
S101
OFF
J301 HI [2]
J302 LOW [0]
J303 GD SHIELD
R101 995K
R102 5K-J 2W
R103 5K-J 2W
C101 .2
CR101 281845-6
CR102 281845-6
R104 5K
TB101
100
50
20
10
5
2
1
.5
.2
.1
C104 1.0
C105 .25
C106 .02
C107 .02
R113 5K
R114 3K
R115 1K
R116 500
R117 300
R118 100
R119 50
R120 30
R121 10
R122 10

SYM.	DESCRIPTION	DATE	APPROVAL
A-1	U104 WAS: 301 DCN 20464	8/22/75	
B-		11/15/75	P. M.



NOTES

1. UNLESS OTHERWISE INDICATED
   ALL CAPACITANCE IN MICROFARADS
   ALL RESISTANCE IN OHMS
   ALL VOLTAGES REFERENCED TO CIRCUIT COMMON
2. ALL RESISTORS WITH SUFFIX
   B=.1%-1/4W
   C=.25%-1/4W
   J= 5%-1/2W
3. ALL UNMARKED RESISTORS ARE .05% 1/2W.
4. ARROW ON VARIABLE RESISTORS & SWITCHES DENOTES CW ROTATION.
5. CHASSIS
   GUARD SHIELD
   CIRCUIT COMMON

VARIABLE GAIN AMPLIFIER

BY	DATE	NAME	Gould Inc. Instrument Systems Division
DR SNOWDEN	6/74	SCHEMATIC MODEL NO. 13-4715-06	Cleveland, Ohio 44114 U.S.A.
CH		CODE IDENT. 96795	ISSUE CODE G
APP			DWG NO. 286361

FIGURE 8-20 HIGH GAIN MULTI SPAN AMPLIFIER SCHEMATIC (286361)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
MEDIUM GAIN MULTI SPAN PREAMPLIFIER ASSY (13-4715-09)
FIGURE 8-21

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	286006-6	Post, Binding, Blue	J-303
2	286006-10	Post, Binding, Blk	J-302
3	286006-2	Post, Binding, Red	J-301
4	285651-4	Knob	
5	285651-2	Knob	
6	285653-1	Knob	
7	788537	Panel Assy., Silkscreen	
8	788432	Bracket Assy	
9	867052-49	Cable Assy	
10	861810-364	Cable Assy	
11	243898-62	Nut Assy, Lockwasher	
12	1-216886-303	Block, Terminal	
13	286083	Bracket, Terminal Mtg.	
14	888536	Board Assy (see Fig. 8-22)	
†15	269094-103	Resistor, Variable	R-229

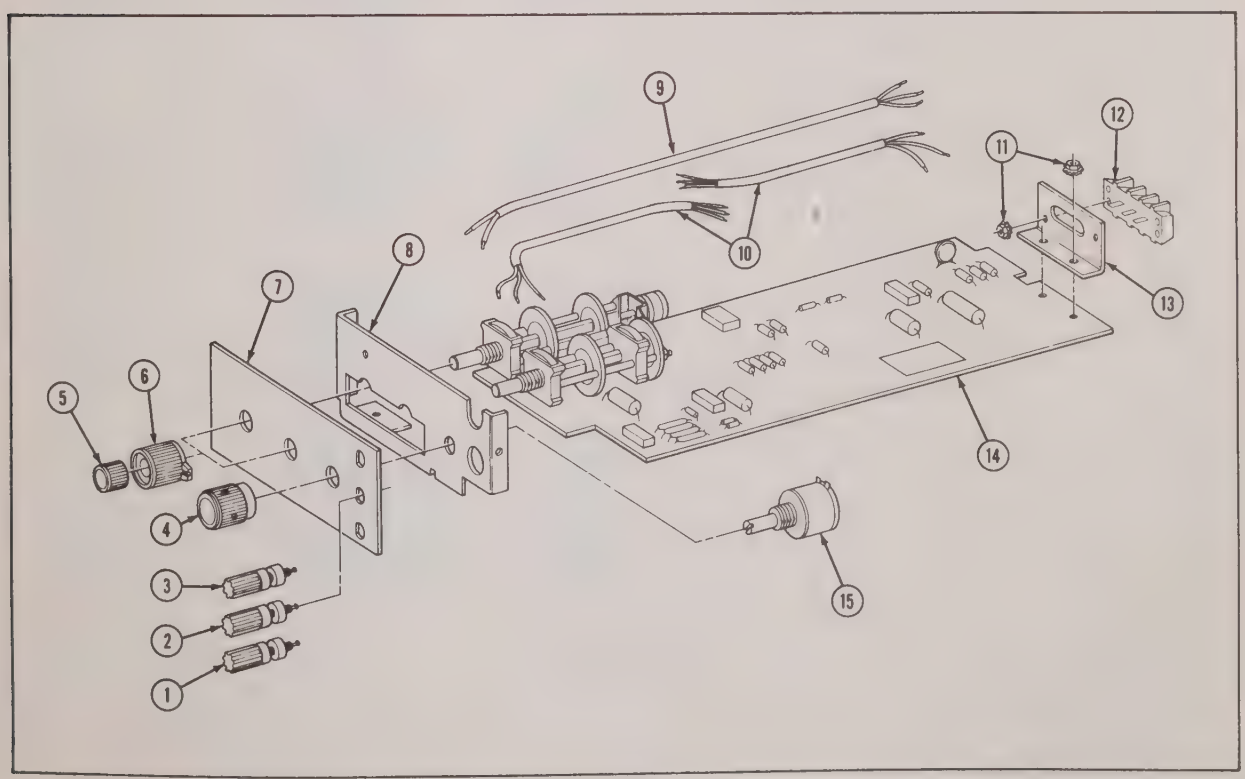


FIGURE 8-21 MEDIUM GAIN MULTI SPAN AMPLIFIER ASSY (13-4715-09)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
MEDIUM GAIN MULTI SPAN PREAMPLIFIER BOARD ASSY (888536)
FIGURE 8-22

ITEM NO	PART NUMBER	DESCRIPTION
C101	10-241145-304	Capacitor
C102	5-241145-134	Capacitor
C103	5-241145-135	Capacitor
C104	240352-103	Capacitor
C105	5-241145-104	Capacitor
C106	5-241145-105	Capacitor
C107, 108	262956-226	Capacitor
C109	240352-201	Capacitor
C111, 112	283943-11	Capacitor
†CR101, 102	288072	Diode, 1N3595
†U101	288071-1	Integrated Circuit 05EY
†U102	280863-3	Integrated Circuit 741
†U103	281101	Integrated Circuit MC1456
†U104	1-288481	Resistor Network
R101	R1-284694-99002	Resistor
†R102	269085-201	Resistor, Variable
R103	R1-284694-99000	Resistor
R105	5-241111-226	Resistor
†R106	269085-202	Resistor, Variable
R107	1-265969-50001	Resistor
R108, 109	1-265969-10000	Resistor
R110	1-265969-50001	Resistor
R111	288306-10001	Resistor
†R112	282299-203	Resistor, Variable
R113	1-265969-10000	Resistor
R114	1-265969-99001	Resistor
R115	1-265969-50001	Resistor
R125, 126	1-265969-10002	Resistor
†R127	282299-103	Resistor, Variable
R128	1-265969-20002	Resistor
R130	1-265969-26000	Resistor
R131	1-265969-400R0	Resistor
R132	1-265969-26000	Resistor
R133	1-265969-400R0	Resistor
†R134	268940-254	Resistor, Variable
†S101	288320	Switch, Rotary
†S103	288318	Switch, Rotary

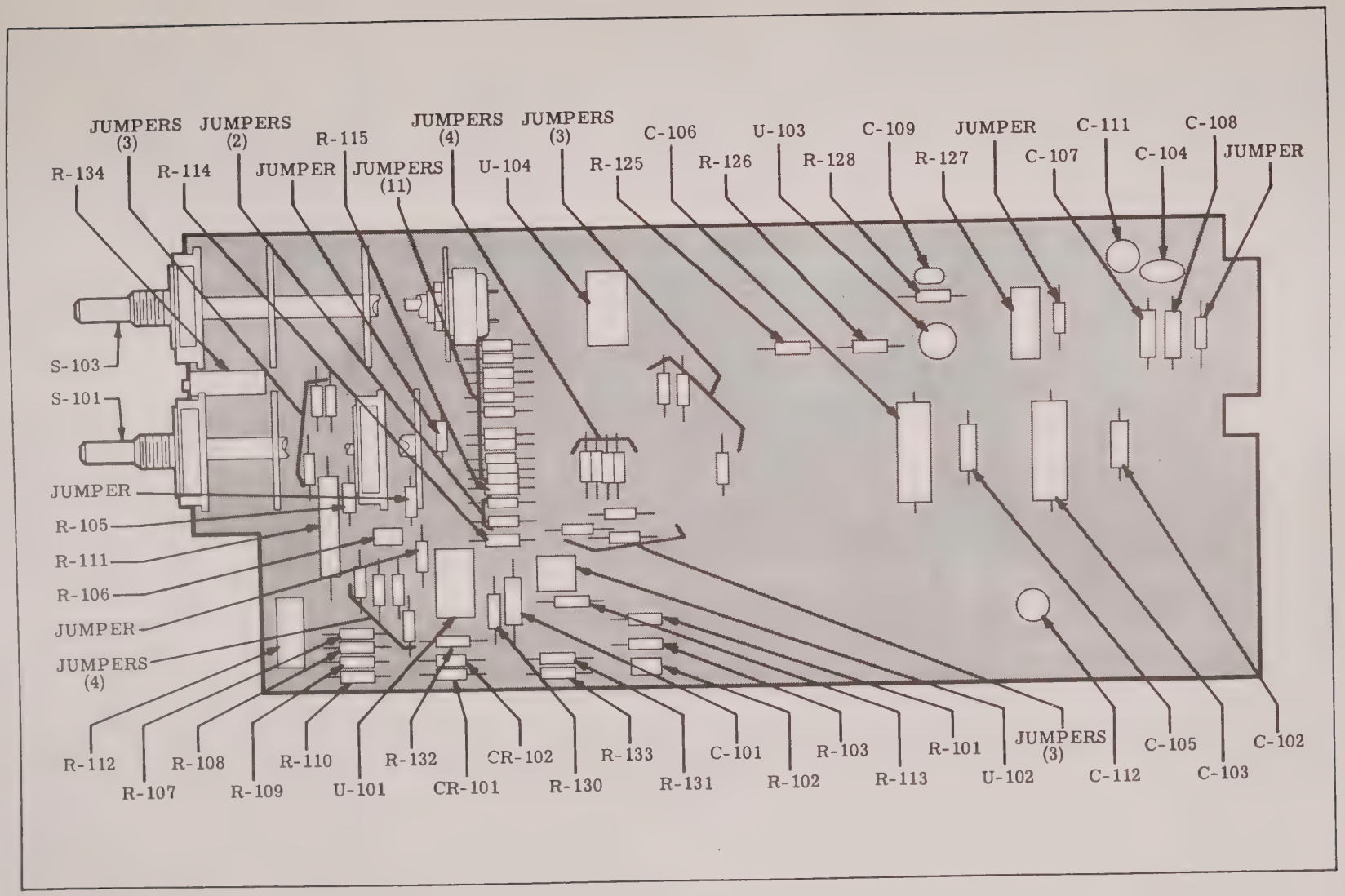
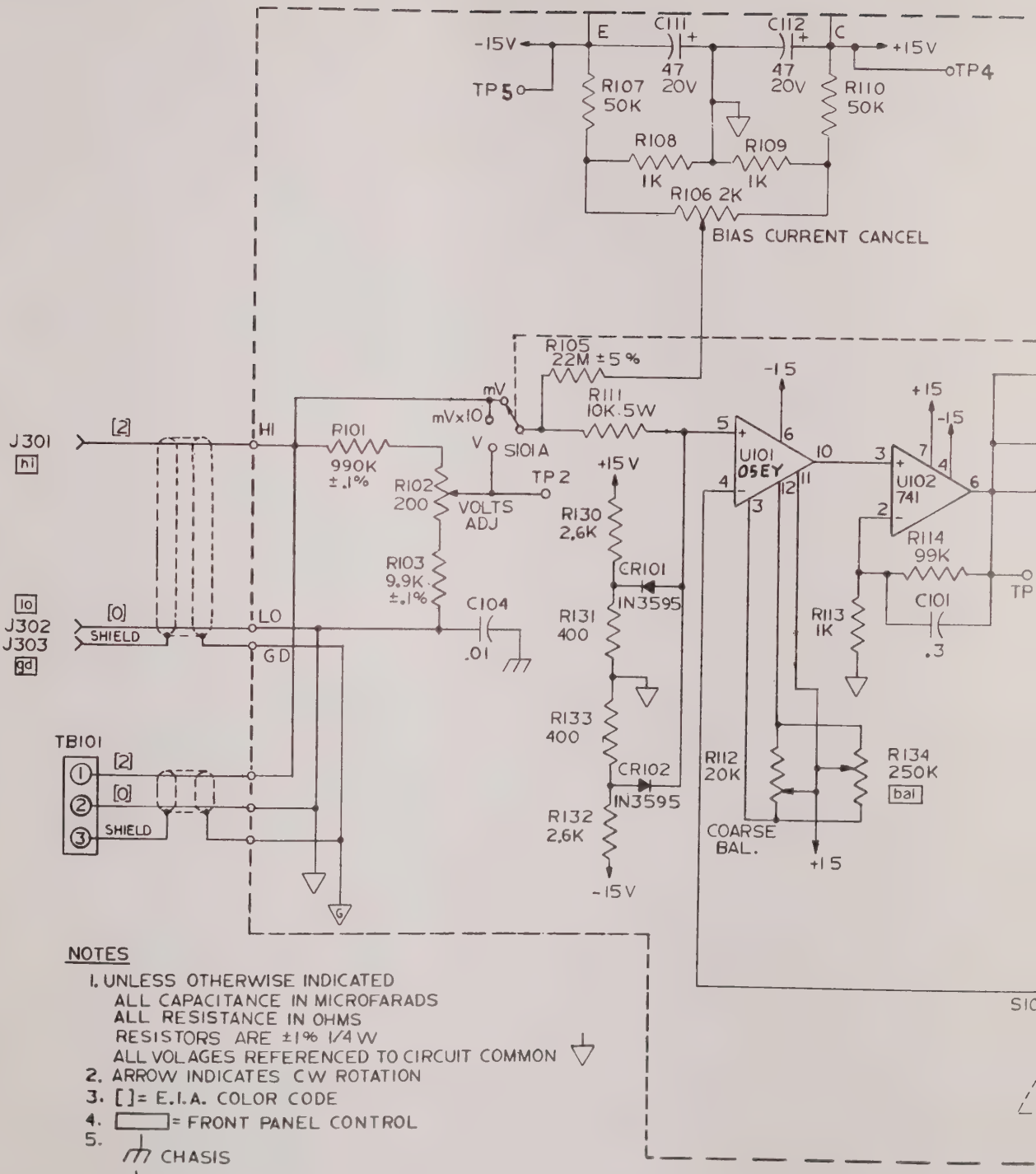
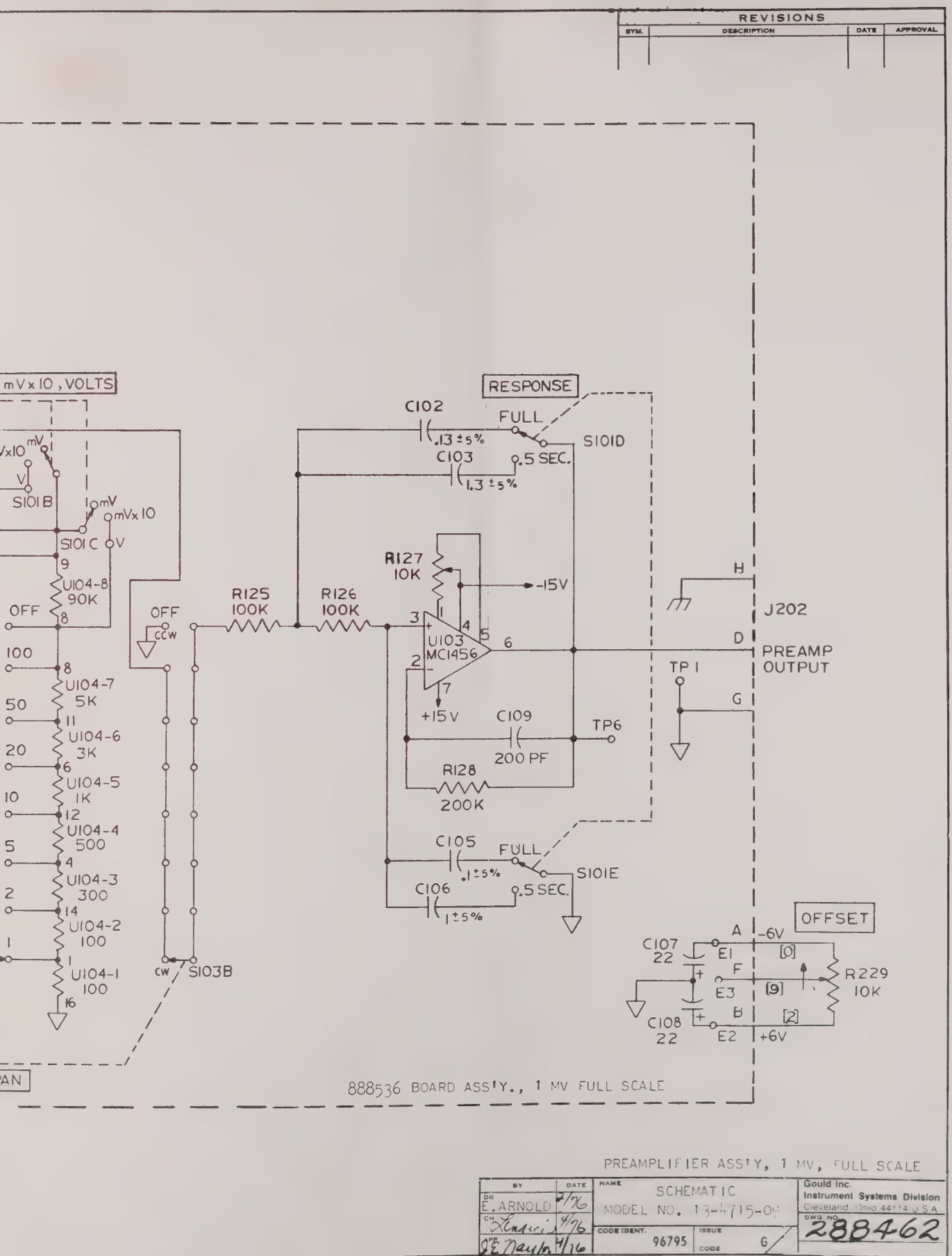


FIGURE 8-22 MEDIUM GAIN MULTI SPAN AMPLIFIER BOARD ASSY (888536)



NOTES

1. UNLESS OTHERWISE INDICATED
   ALL CAPACITANCE IN MICROFARADS
   ALL RESISTANCE IN OHMS
   RESISTORS ARE ±1% 1/4 W
   ALL VOLAGES REFERENCED TO CIRCUIT COMMON
2. ARROW INDICATES CW ROTATION
3. [ ]= E.I.A. COLOR CODE
4. ▭ = FRONT PANEL CONTROL
5. CHASIS
   GUARD SHIELD



PREAMPLIFIER ASS'Y, 1 MV, FULL SCALE

BY	DATE	NAME		
DR E. ARNOLD	4/76	SCHEMATIC MODEL NO. 13-4715-09	Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.	
CH [illegible]	4/76	CODE IDENT. 96795	ISSUE CODE G	DWG NO 288462
QE [illegible]	4/76			

FIGURE 8-23 MEDIUM GAIN MULTI SPAN AMPLIFIER SCHEMATIC (288462)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
LIMIT SWITCH ASSY OPTION (SINGLE CHANNEL 11-6103-01) (DUAL CHANNEL 11-6103-02)
FIGURE 8-24

ITEM NO	PART NUMBER	DESCRIPTION
1	287007	Label, Limit Controls
2	385108	Panel, Limit Controls
3	263451-4	Guide, P.C. Board
4	1-286155-6	Board, Terminal
		(Attaching Parts)
	31-119918-6210	Screw, Pan
	1-216741-420	Lockwasher, Spring
	31-119998-62	Nut, Hex
5	886705	Board Assy, Limiter (Single Channel) } See Fig.8-25
	886707	Board Assy, Limiter (Dual Channel) } See Fig.8-25
6	286756	Bracket, Cable
7	9-281501-15	Connector
8	281502	Contact, Elect.
9	1-283408-1	Contact
10	265915-1	Contact
11	385110	Panel, Fill

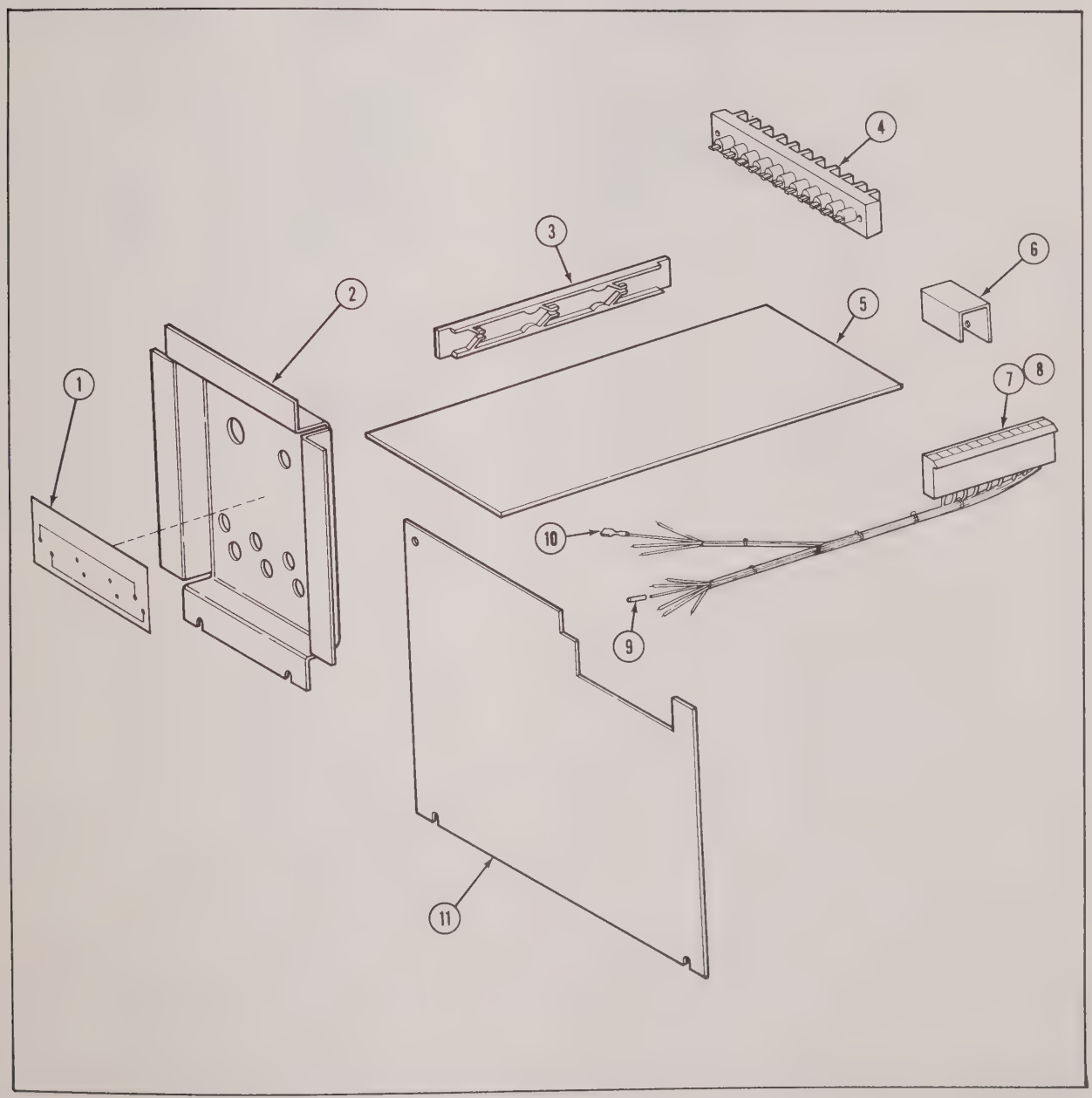


FIGURE 8-24 LIMIT SWITCH ASSY (11-6103-01, 02)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
LIMIT SWITCH BOARD ASSY (SINGLE CHANNEL 886705)
FIGURE 8-25 (Sheet 1 of 3)

ITEM NO	PART NUMBER	DESCRIPTION
C101, C102	240352-103	Capacitor
C103, C104	240352-300	Capacitor
†CR101, CR102	280440	Semiconductor, 1N4148
†CR103, CR104	231887	Semiconductor, SI-1
†CR105, CR106	285578	Semiconductor, LED
†K101, K102	285771-24	Relay
P101	281711-15	Connector
†Q101	268934-2	Semiconductor, MPS 6531
†Q102	283658-2	Semiconductor, MPS 6534
R101, R104	5-241111-223	Resistor
†R102, R103	20-285471-104	Resistor, Vari.
R105, R106	5-241111-104	Resistor
R107 Thru R110	5-241111-333	Resistor
R111, R112	5-241111-156	Resistor
R113, R114	5-241111-752	Resistor
R115, R116	5-241111-101	Resistor

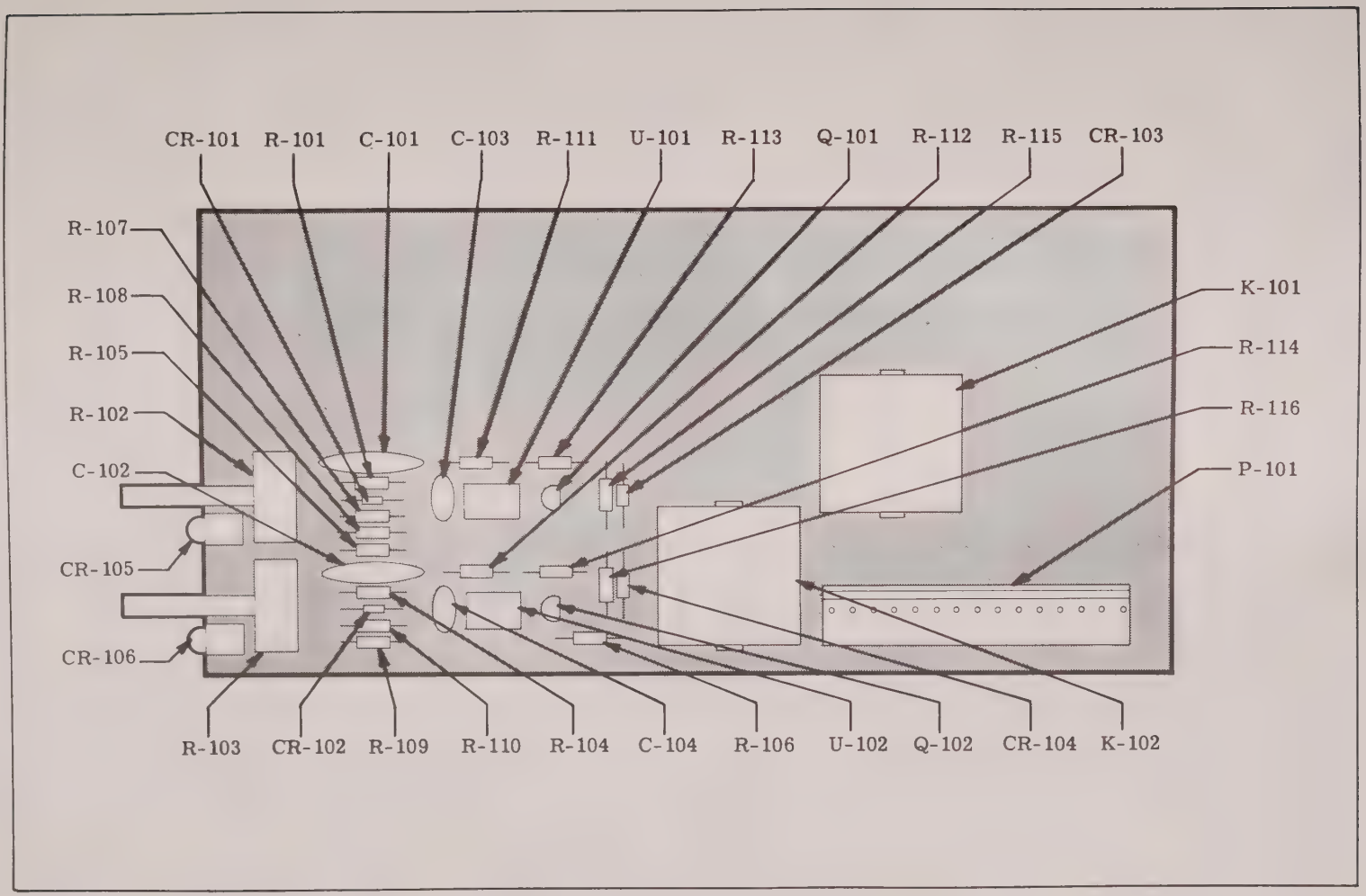


FIGURE 8-25 LIMIT SWITCH BOARD ASSY (SINGLE CHANNEL 886705) (Sheet 1 of 3)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
LIMIT SWITCH BOARD ASSY (DUAL CHANNEL 886707)
FIGURE 8-25 (Sheets 2 & 3 of 3)

ITEM NO	PART NUMBER	DESCRIPTION
C101, C102 C105, C106	240352-103	Capacitor
C103, C104 C107, C108	240352-300	Capacitor
†CR101, CR102 †CR107, CR108	280440	Semiconductor, 1N4148
†CR103, CR104 †CR109, CR110	130198-1	Semiconductor, SI-1
†CR105, CR106 †CR111, CR112	285578	Semiconductor, LED
†K101 Thru †K104	285771-24	Relay
†P101, P102	281711-15	Connector
†Q101, Q103	268934-2	Semiconductor, MPS 6531
†Q102, Q104	283658-2	Semiconductor, MPS 6534
R101, R104 R117, R120	5-241111-223	Resistor
R102, R103 †R118, R119	20-285471-104	Resistor, Vari.
R105, R106 R121, R122	5-241111-104	Resistor
R107 thru R110 R123 thru R126	5-241111-333	Resistor
R111, R112 R127, R128	5-241111-156	Resistor
R113, R114 R129, R130	5-241111-752	Resistor
R115, R116 R131, R132	5-241111-101	Resistor
†U101 Thru †U104	230062-1	Semiconductor, LM 301

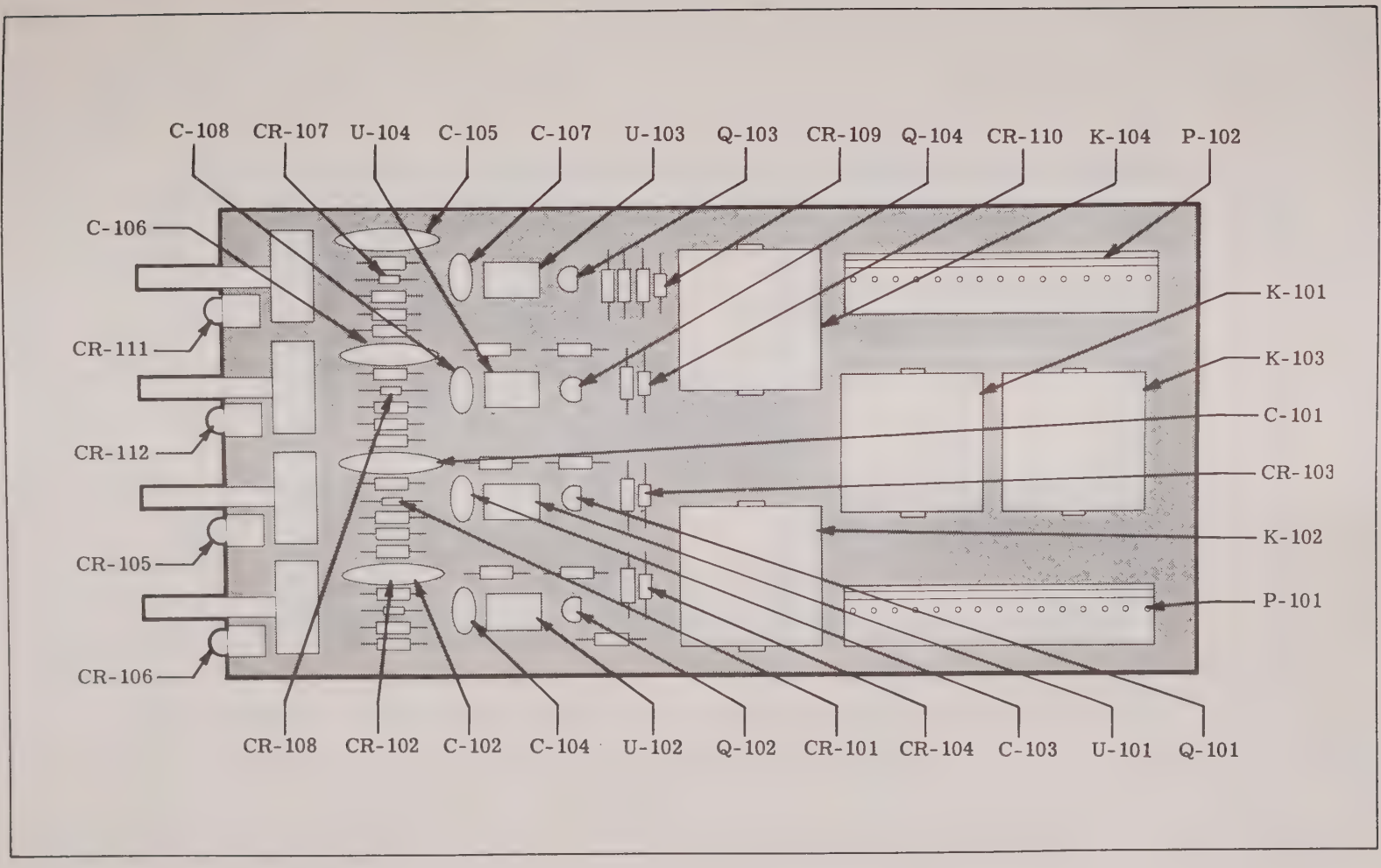


FIGURE 8-25 LIMIT SWITCH BOARD ASSY (DUAL CHANNEL 886707)
(Sheet 2 of 3)

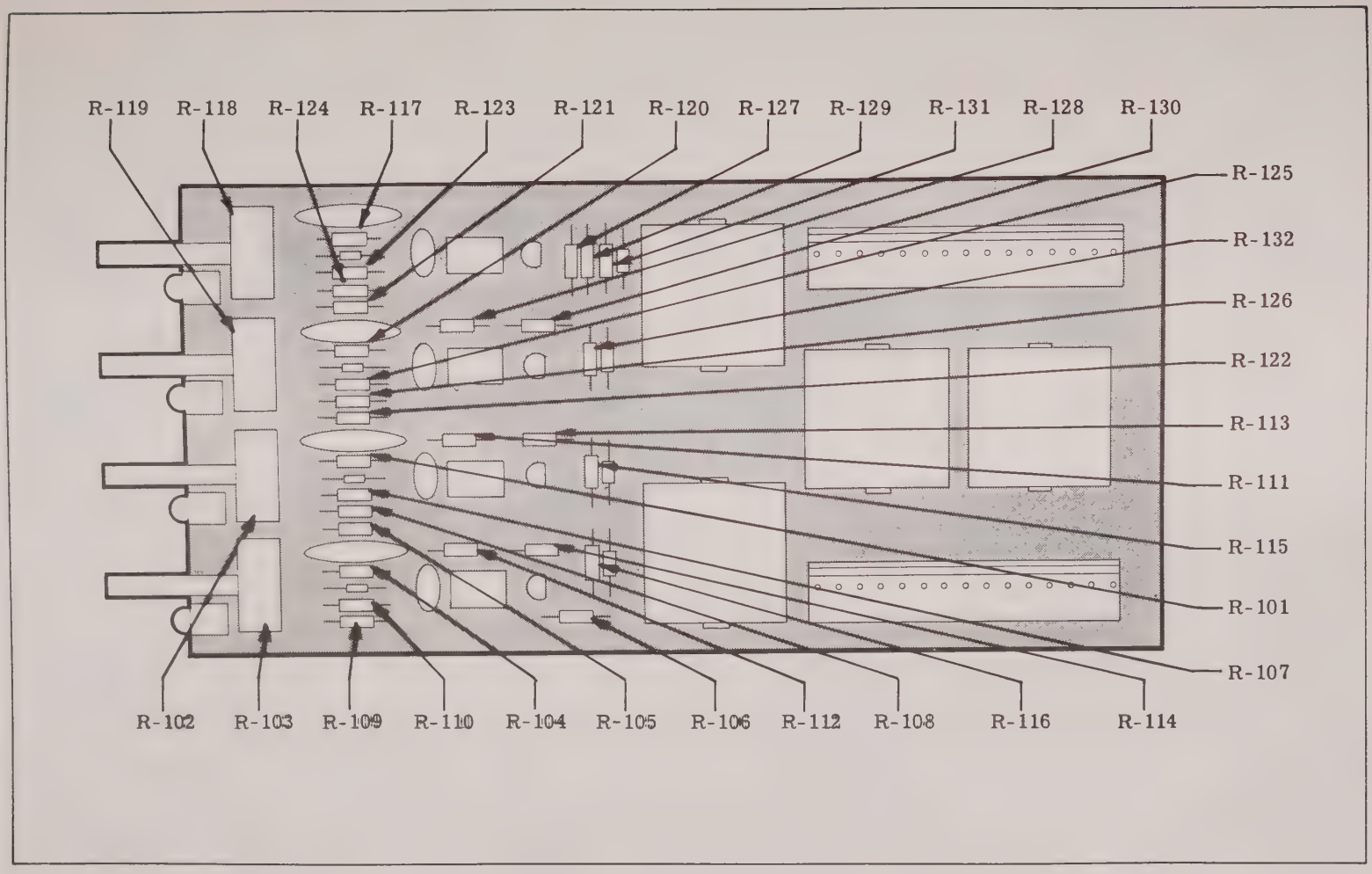


FIGURE 8-25 LIMIT SWITCH BOARD ASSY (DUAL CHANNEL 886707)
(Sheet 3 of 3)

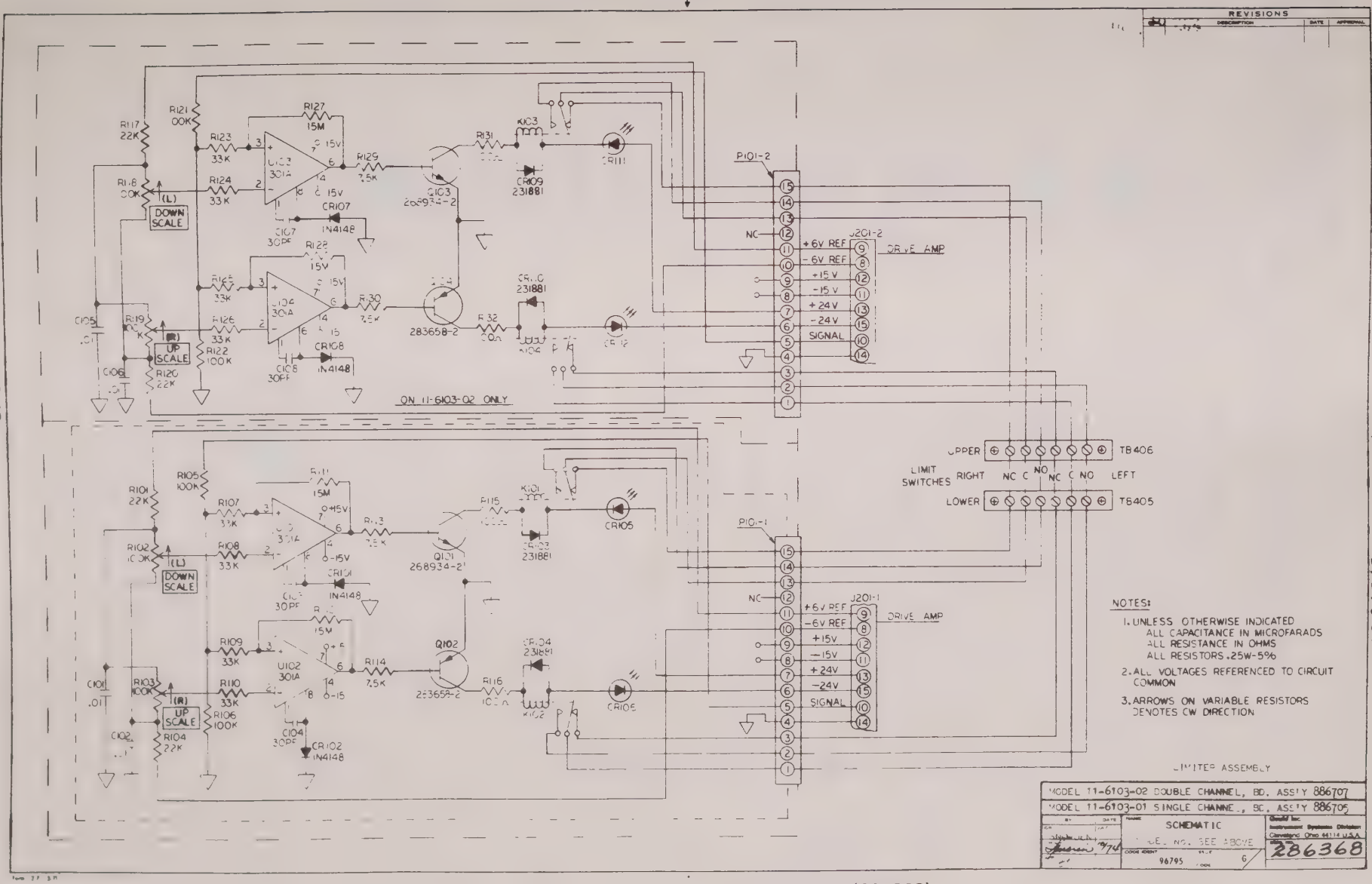


FIGURE 8-26 LIMIT SWITCH SCHEMATIC (286368)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INTEGRATOR PEN OPTION (SINGLE CHANNEL 11-6105-00) (DUAL CHANNEL 11-6105-01)
FIGURE 8-27 (Sheet 1 of 2)

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	786282	Scale Assy S.S.	
2	11-2874-33	Stylus Assy	
3	686281-2	Bumper	
		Harness Assy	
4	9-281501-15	Connector	J-101
5	281502	Contact	
6	265760-1	Contact	
7	9-281501-10	Connector	J-201
† 8	262852	Switch	S-101
† 9	230064-103	Resistor, Variable	R-403
10	1-283408-1	Contact	
11	280757	Connector	J-301
12	4-281501-6	Connector	J-104
13	286768	Pulley	
14	281585	Cable	
15	386649	Sector, Integrator	
16	682145	Drive Band Assy	
17	31-241908-2602	Screw, Cap, Skt, Hd.	
18	281396	Washer, Band	
19	782236	Arm Assy Drive	
20	267598	Bearing, Ball	
21	286645	Gear, Pinion	
22	31-121166-2602	Screw, Set	
23	2-269579-2	Spacer	
24	786650	Bearing, Retainer Mod	
25	243225-3	Clamp, Cable	
26	386647	Plate, Mtg	
27	286655	Clamp, Motor	
28	286653	Clamp, Pot	
† 29	50-286149-103	Pot, Feedback	
30	265827-4	Spacer	
31	281622-1	Shaft	
32	286651	Plate, Bearing	
33	230066	Washer, Spacer	
34	9-227070-6	Ring, Retainer	
† 35	285583	Motor, Drive	

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INTEGRATOR PEN OPTION (SINGLE CHANNEL 11-6105-00) (DUAL CHANNEL 11-6105-01)
FIGURE 8-27 (Sheet 2 of 2)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
36	385110	Panel, Fill	
37	285651-4	Knob	
38	385108	Panel, Limit Controls	
39	286666	Label	
40	886046-2	Board Assy, Drive Amp (See Fig. 8-10)	
41	263451-4	Guide, P.C. Board	
42	886663	Board Assy, Integrator (See Fig. 8-28 & 8-30)	
43	265849-4	Bracket	
44	267235	Jumper	
45	786661	Power Supply (See Fig. 8-29 & 8-30)	
46	124804-4	Clamp, Cable	
47	765980	Hub, Pen-Machined	
48	249264-1	Sleeve	
49	232851-2603	Screw	
50	31-129647-26	Nut, Hex	

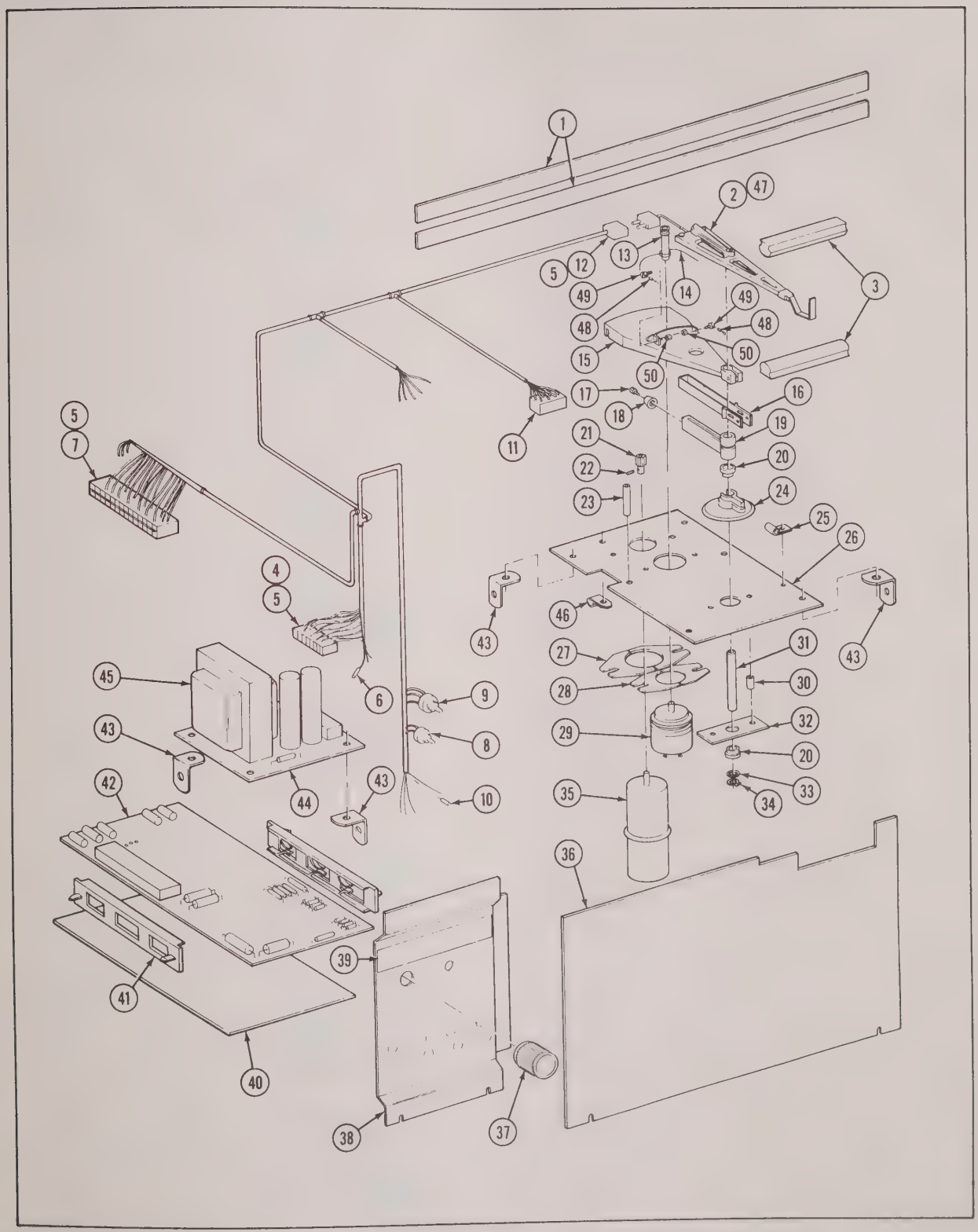


FIGURE 8-27 INTEGRATOR PEN OPTION (SINGLE AND DUAL CHANNEL 11-6105-00, -01)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INTEGRATOR BOARD ASSY 886663
FIGURE 8-28

ITEM NO	PART NUMBER	DESCRIPTION
C101	230098-104	Capacitor
C102	10-287730-106	Capacitor
C103	10-241145-504	Capacitor
C104	281344-103	Capacitor
C105	232920-336	Capacitor
C106	10-241145-474	Capacitor
C107	10-241145-105	Capacitor
C108	263343-156	Capacitor
C109	10-241145-404	Capacitor
C110	263343-156	Capacitor
C111	10-241145-404	Capacitor
†CR101, CR102	263727	Semiconductor, Diode 1N961B
†CR103	280440	Semiconductor, Diode 1N4148
P101	281711-15	Connector
†Q101	230057-1	Semiconductor Transistor 2N4921
†Q102	230058-1	Semiconductor Transistor 2N4918
R101, R102	25-284694-10002	Resistor
R103	25-265969-10000	Resistor
R104	25-284694-10002	Resistor
R105	25-284694-20002	Resistor
†R106	269085-503	Resistor, Variable
R107	R1-284694-10001	Resistor
R108	25-284694-85000	Resistor
†R109	269085-202	Resistor, Variable
R110, R111	25-284694-10002	Resistor
†R112	269085-104	Resistor, Variable
R113	25-265969-10000	Resistor
R114	5-241111-392	Resistor
R115	R1-284694-10001	Resistor
R116	R1-284694-25000	Resistor
R117, R118	5-241111-242	Resistor
R119	R1-284694-10001	Resistor
R120	R1-284694-25000	Resistor
R121	5-241111-393	Resistor
R122	R1-284694-10001	Resistor
R123	R1-284694-75000	Resistor
R124	R1-284694-25000	Resistor
R125, R126	5-241111-472	Resistor
R127	R1-284694-25000	Resistor
R128	R1-284694-75000	Resistor

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INTEGRATOR BOARD ASSY 886663
FIGURE 8-28

ITEM NO	PART NUMBER	DESCRIPTION
R129	R1-284694-10001	Resistor
R130	1-265969-40000	Resistor
R131	25-265969-80000	Resistor
R132	25-265969-40001	Resistor
R133	25-265969-8000	Resistor
†R134	282299-503	Resistor, Variable
R135	25-265969-33001	Resistor
R136	25-265969-10001	Resistor
R137, R138	25-284694-10002	Resistor
R139, R140	25-284694-50001	Resistor
R141	5-241111-682	Resistor
R142	25-265969-58001	Resistor
†R143	282299-202	Resistor, Variable
R144	25-265969-10003	Resistor
R145, R146	5-246857-220	Resistor
R147	25-284694-50000	Resistor
†R149	282299-502	Resistor, Variable
R150	25-265969-15001	Resistor
R153, R154	25-284694-10002	Resistor
†R155	269085-103	Resistor, Variable
R156	25-265969-12000	Resistor
R157	R1-284694-25000	Resistor
R158	25-284694-50000	Resistor
R159	5-241111-472	Resistor
R160	R1-284694-25000	Resistor
R161	R1-284694-10001	Resistor
R162	5-241111-472	Resistor
R163	R1-284694-10001	Resistor
R164	25-265969-10001	Resistor
†S101	247431	Switch, Slide, SPDT
†U101, U102	287740	Integrated Circuit, CA324E
†U103, U104	287602	Integrated Circuit, MPQ6700
†U105	270622	Integrated Circuit, SN7493AN
†U106	287498	Integrated Circuit, MC7812
†U107	287496	Integrated Circuit, MC7912
†U108	281115-1	Integrated Circuit, LM309

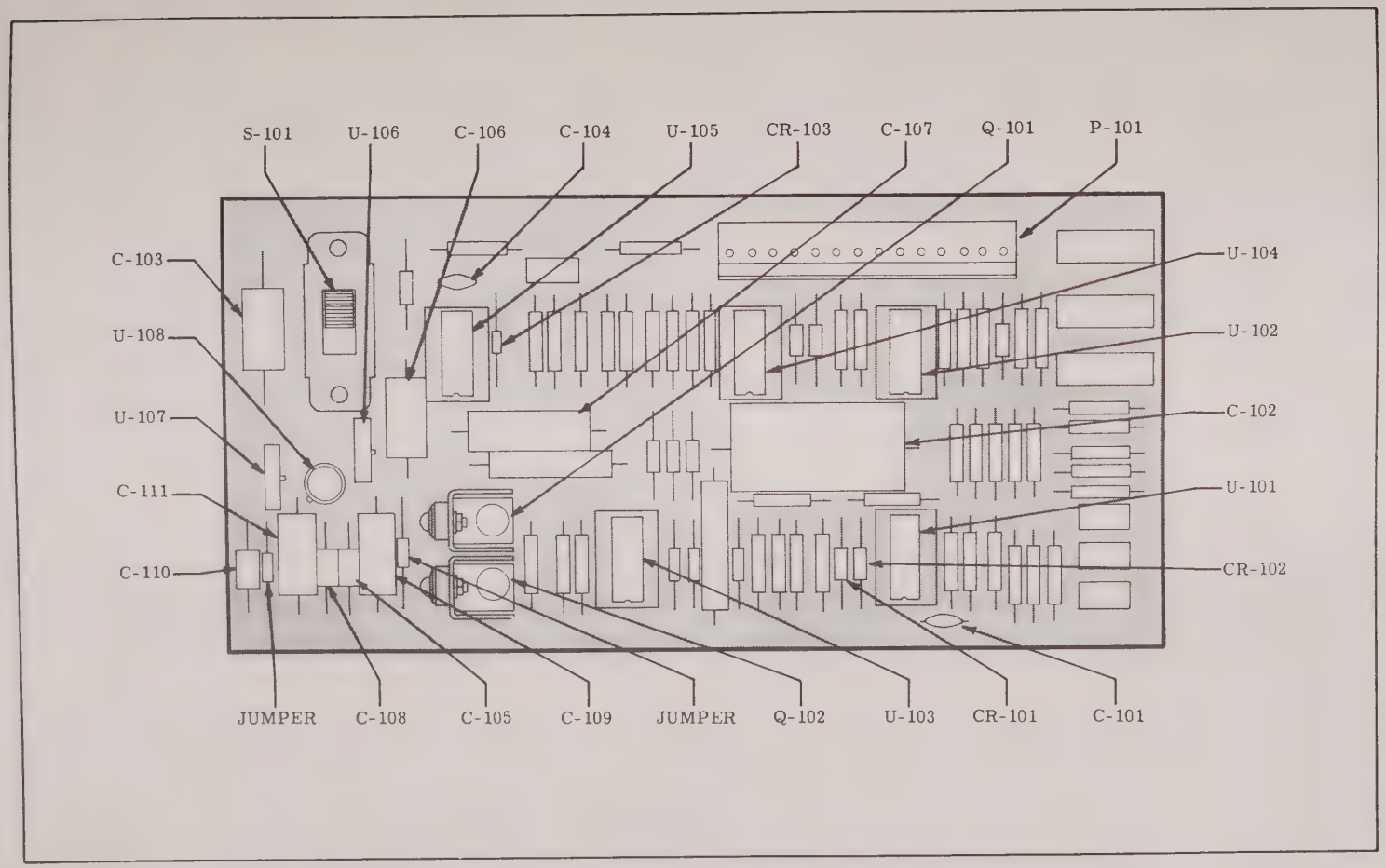


FIGURE 8-28 INTEGRATOR BOARD ASSY 886663 (Sheet 1 of 2)

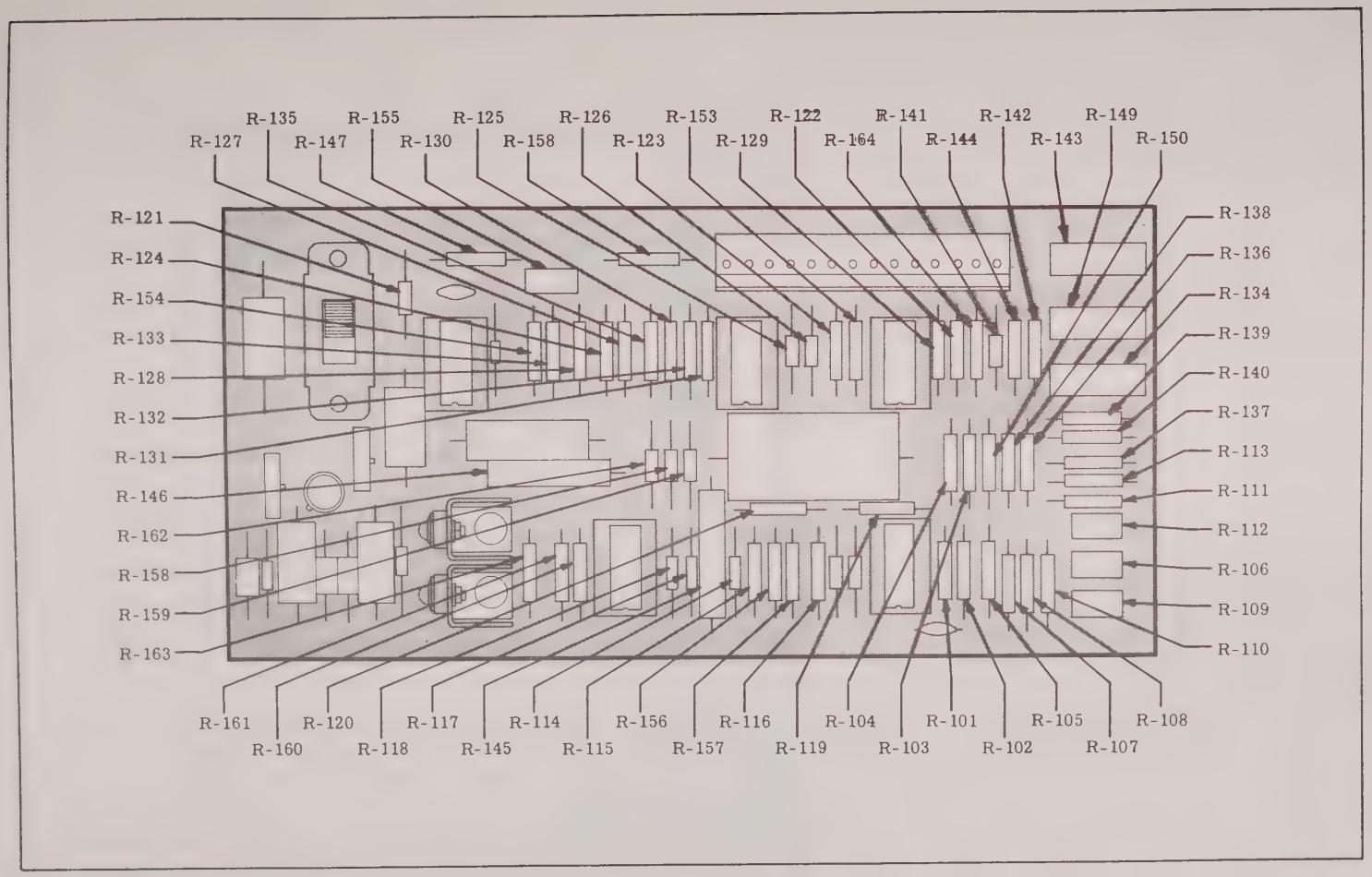


FIGURE 8-28 INTEGRATOR BOARD ASSY 886663 (Sheet 2 of 2)

EXPLODED VIEW PARTS LIST
GOULD 110 RECORDER
INTEGRATOR POWER SUPPLY BOARD ASSY 786661
FIGURE 8-29

ITEM NO	PART NUMBER	DESCRIPTION
C201, C202	281509-507	Capacitor
†CR201	286018-1	Diode Assy
†F201	116198-4	Fuse
†K201	262185	Relay
†P201	281711-10	Connector
†T201	285596	Transformer

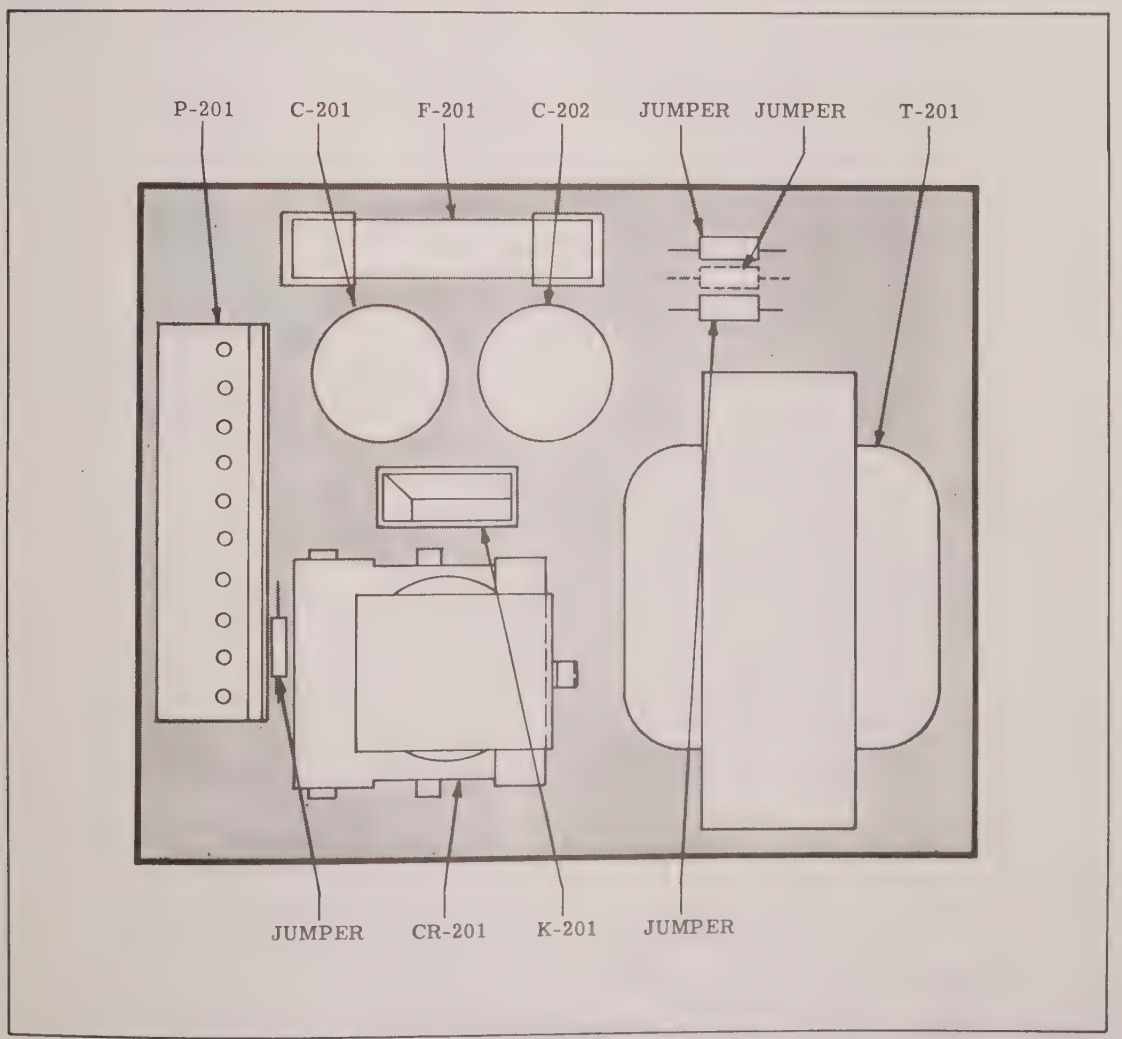
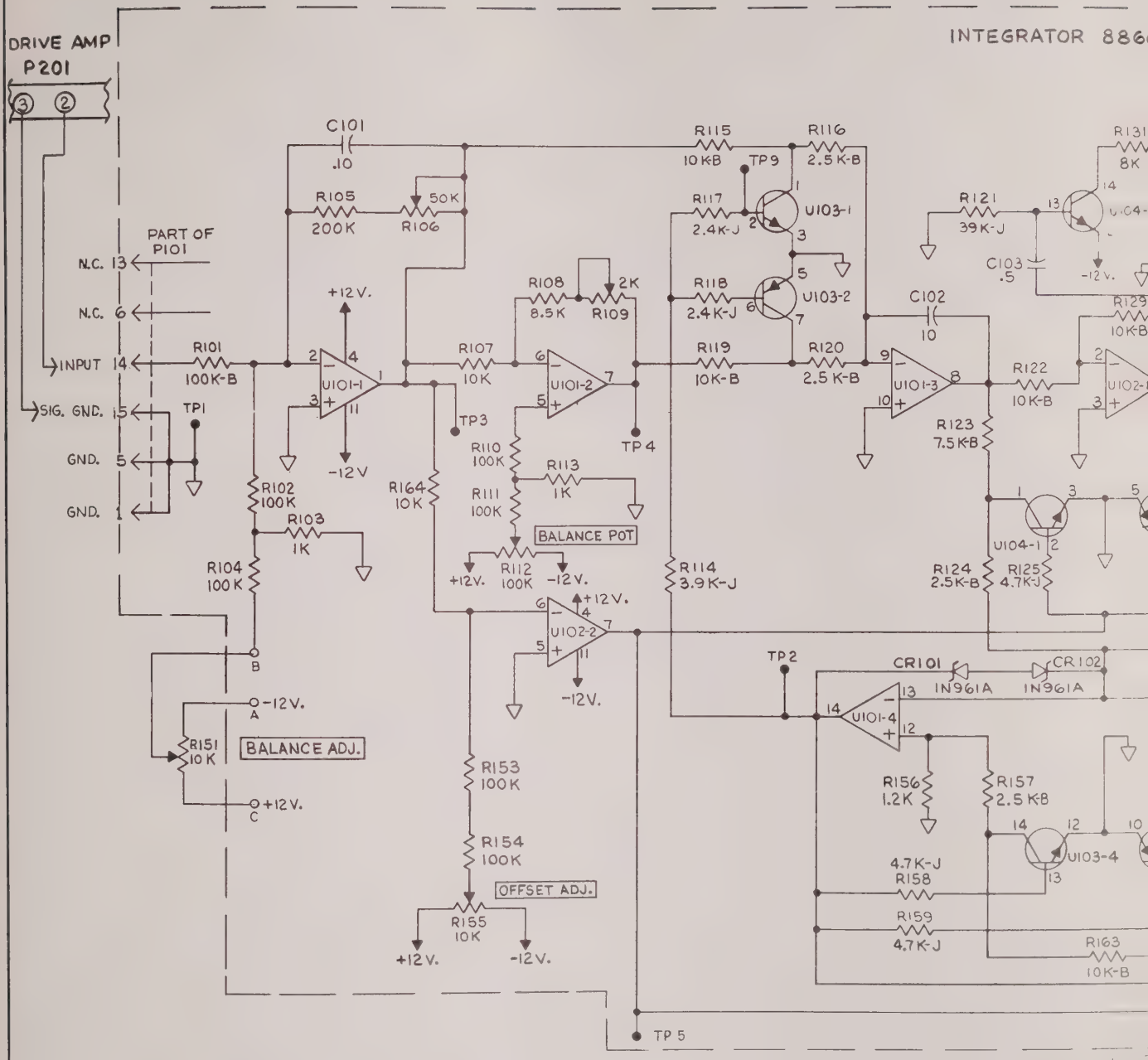


FIGURE 8-29 INTEGRATOR POWER SUPPLY BOARD ASSY 786661



NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL CAPACITANCE IN MICROFARADS.
   ALL RESISTANCE IN OHMS.
   ALL VOLTAGES REFERENCED TO CIRCUIT COMMON.
2. RESISTOR TOLERANCES:
   B = .1%. 1/4 W
   J = 5% 1/4 W
3. ARROWS ON VARIABLE RESISTORS & SWITCHES DENOTES CW ROTATION.
4. ▽ DENOTES COMMON FROM DRIVE AMP.
5. R151 ON SUBPANEL BEHIND SUPPLY ROLLS.
6. S202 ON SUBPANEL NEXT TO R151.

RECORDER CONTROL ASSY. 886394

PEN HEATER

PEN 11-2874-33

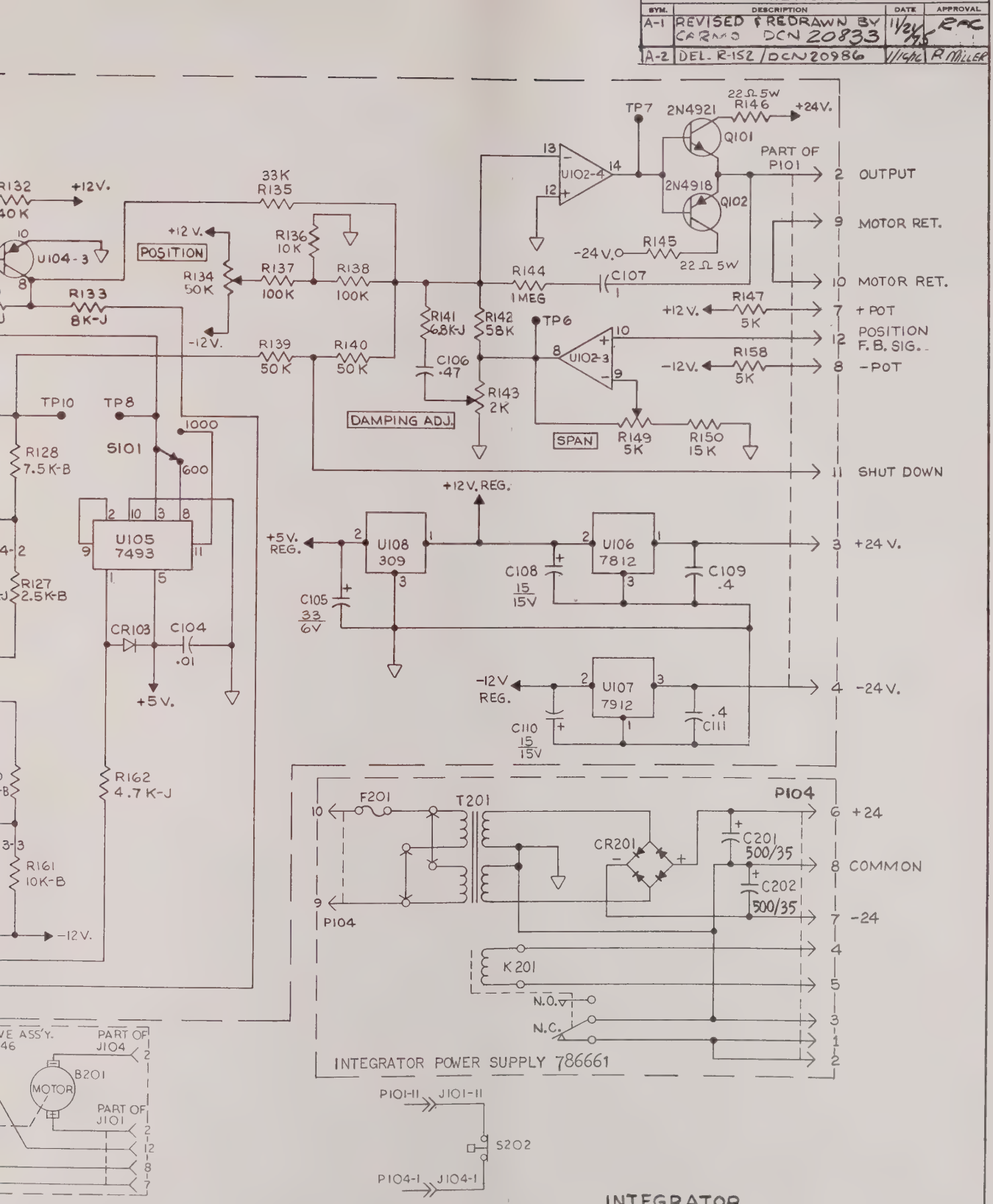


FIGURE 8-30 INTEGRATOR PEN SCHEMATIC (286366)

PICTORIAL VIEW PARTS LIST
GOULD 110 RECORDER
RETRANSMITTING POTENTIOMETER ASSY – SINGLE CHANNEL (11-6102-01)
FIGURE 8-31

ITEM NUMBER	PART NUMBER	DESCRIPTION
*1	885112-3	Pen Drive Assy
2	686495	Harness Assy
3	1-286155-4	Board, Terminal
4	31-119918-6210	Screw, Pan Hd.
5	1-216741-420	Lockwasher, Spring
6	31-119998-62	Nut, Hex

*Item 1 is not procurable. Dual Pot R-402 is (P/N 286150). For other Pen Drive Assy parts not listed here see Figure 8-4.

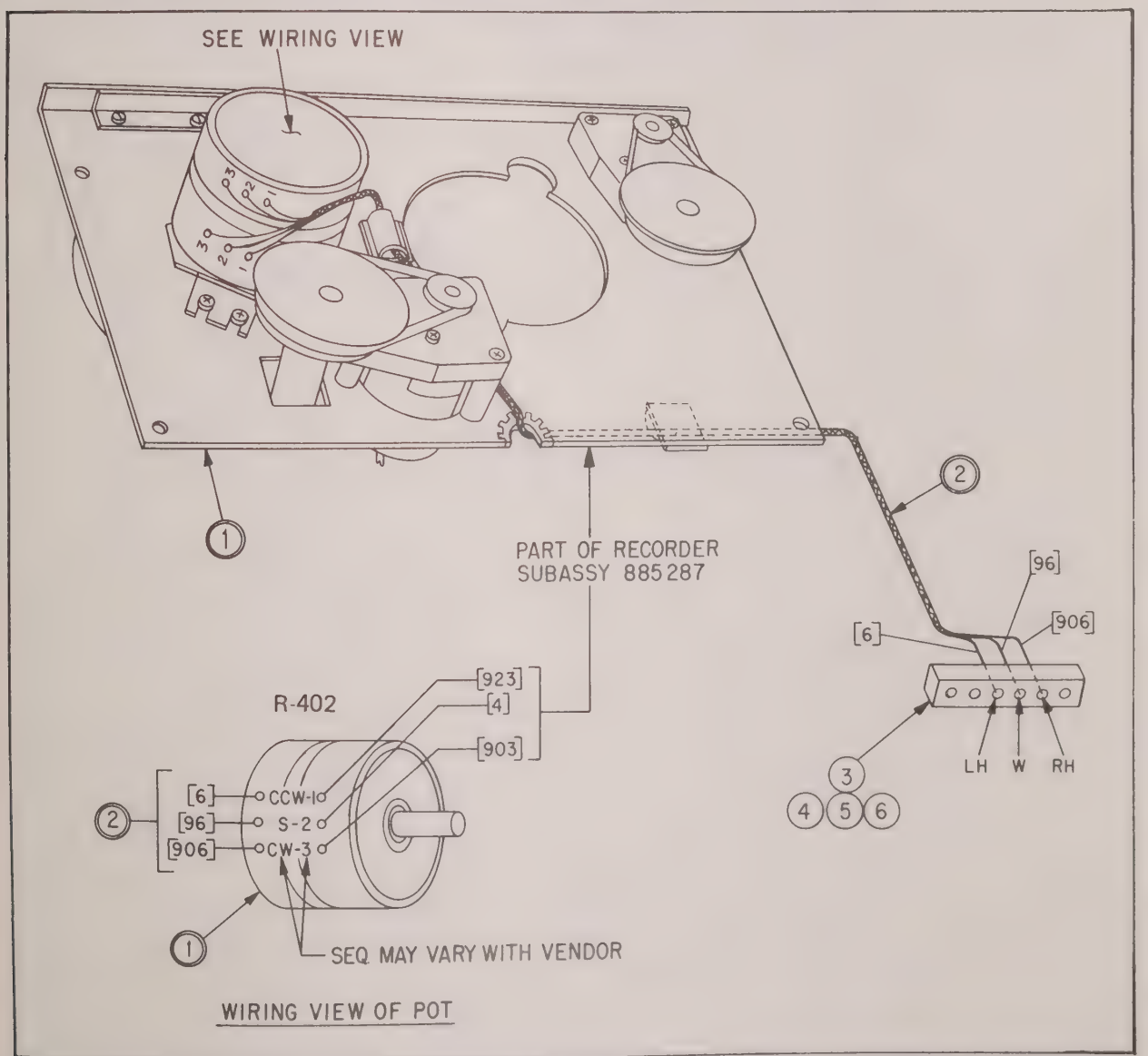


FIGURE 8-31 RETRANSMITTING POTENTIOMETER ASSY – SINGLE CHANNEL (11-6102-01)

PICTORIAL VIEW PARTS LIST
GOULD 110 RECORDER
RETRANSMITTING POTENTIOMETER ASSY – DUAL CHANNEL (11-6102-02)
FIGURE 8-32

ITEM NUMBER	PART NUMBER	DESCRIPTION
*1	786308-2	Bracket Assy., Pot Mtg. (Replacement for 786308-1)
2	686495	Harness Assy
3	1-286155-4	Board, Terminal
4	31-119918-6210	Screw, Pan Hd.
5	1-216741-420	Lockwasher, Spring
6	31-119998-62	Nut, Hex

*Item 1 is the same as Figure 8-4 item 8 (shown exploded in detail A) except item 28 is replaced by dual Pot 286150 (R-402-2). For other pen drive assy parts not listed here see Figure 8-4.

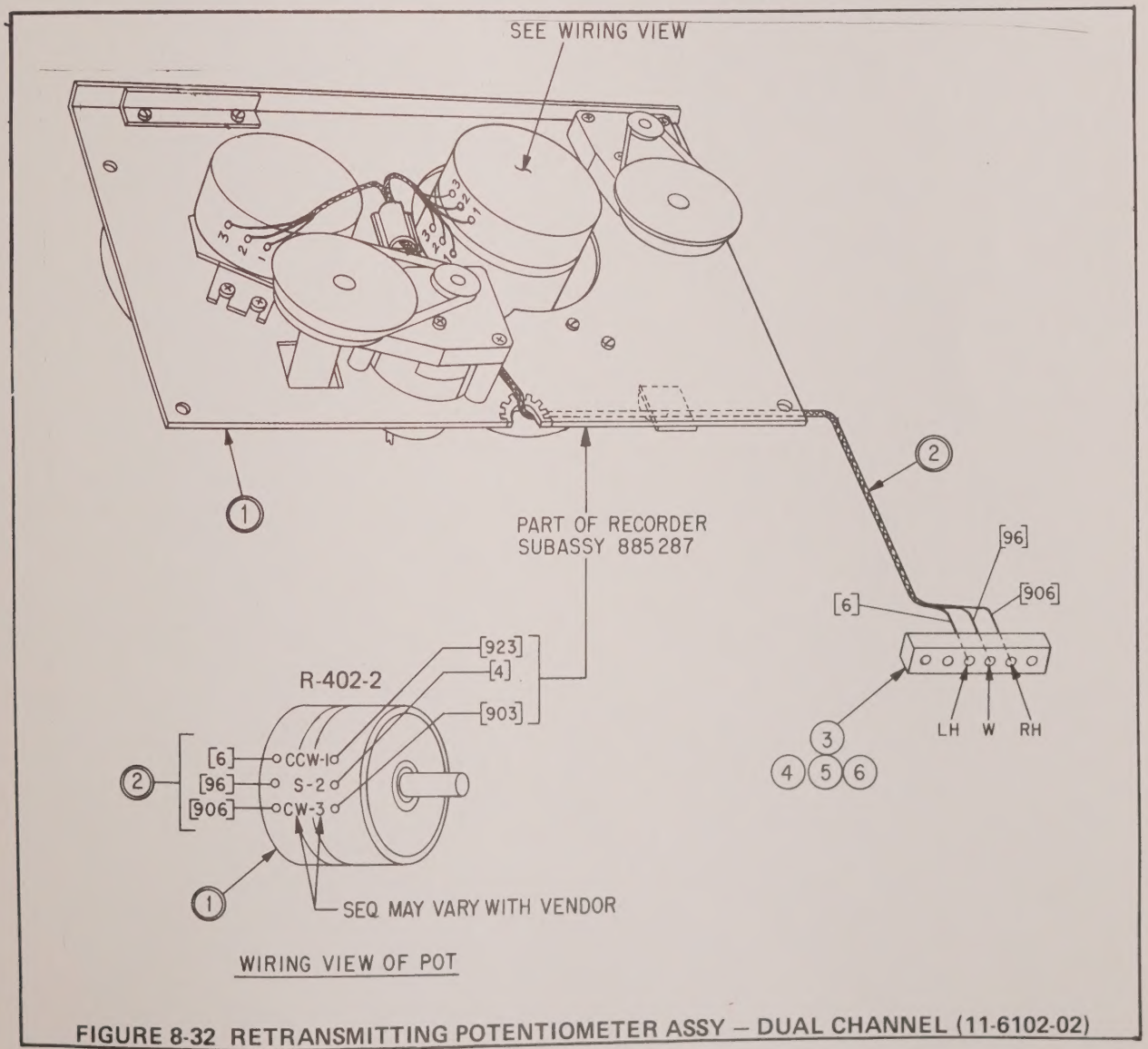
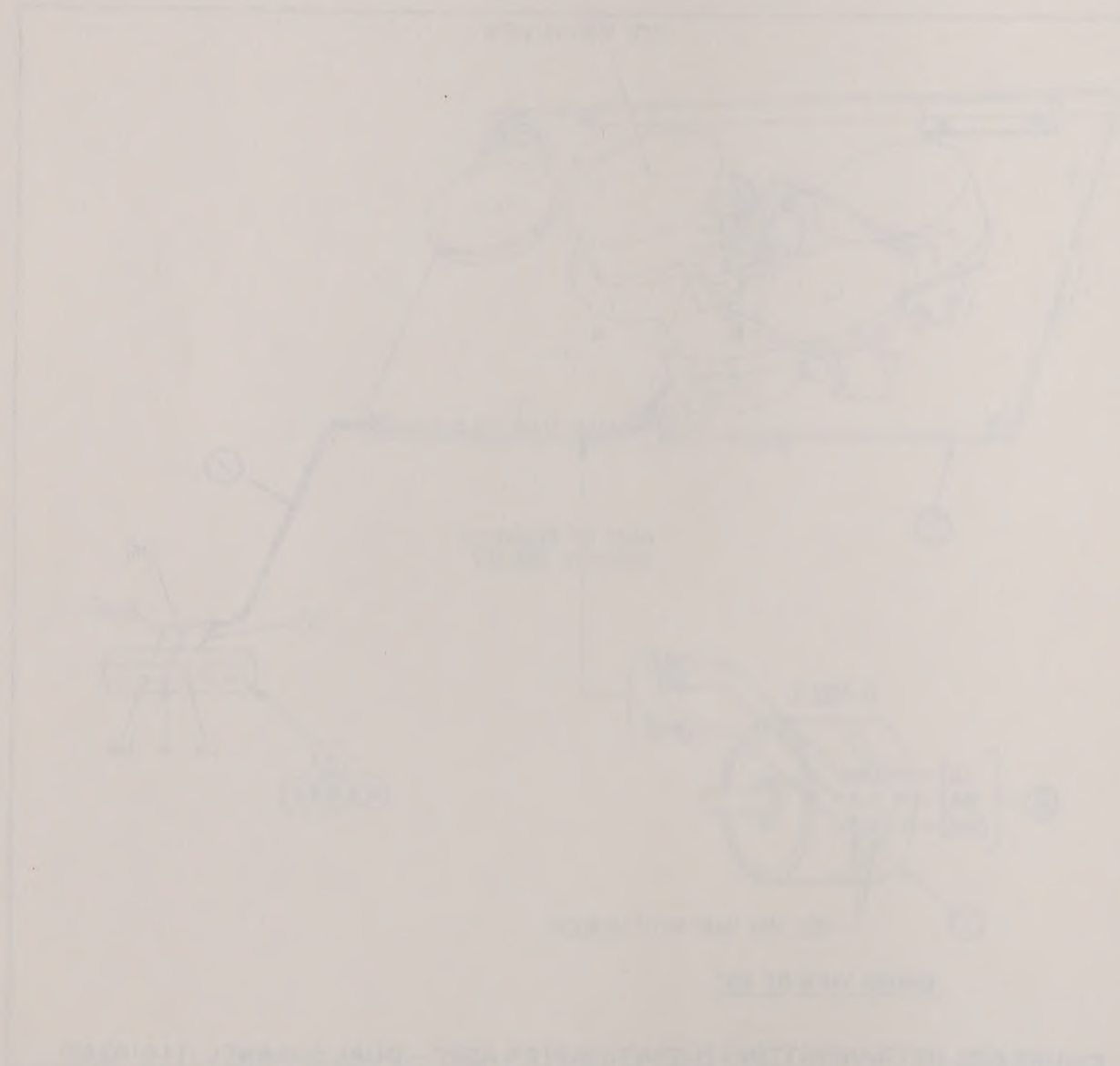


FIGURE 8-32 RETRANSMITTING POTENTIOMETER ASSY – DUAL CHANNEL (11-6102-02)



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